# CPB Memorandum

**CPB Netherlands Bureau for Economic Policy Analysis**



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| Author(s) | : | Kees Folmer |
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## Why do macro wage elasticities diverge?

A meta analysis

This study analyses macro wage elasticities on labour productivity, payroll taxes, average and marginal income tax, consumer and producer prices, the replacement ratio and the unemployment rate. The data have been analyzed in a meta analysis that relates differences in each elasticity of pay to variations in study characteristics, economic or institutional variables and the econometric specification of underlying wage equations. The results indicate that notably the econometric specification of the reported wage equation matters. The dynamic specification, the choice of explanatory variables and restrictions on estimated coefficients all have their impact on estimated elasticities. The reported value of the output price elasticity of pay is sensitive to restrictions on the consumer price and vice versa. In case of tax elasticities the dynamic specification matters, and the value of the replacement ratio elasticity of pay based on sectoral data is higher than the one obtained from macro data. The results for the unemployment elasticity of pay are close to those found in the wage curve literature. Finally, we generate benchmark values for each type of elasticity.

# Contents

# 1 Wages through the ages

## 1.1 Scope of the study

Wages and wage formation have always been central items in economics. In addition many empirical studies have investigated the practical impact of wages on economic performance. Roughly spoken, there are three lines of approach. The first is the relation between wages, production and prices. This research was partly triggered by high inflation rates in the 1960s and 1970s of the 20th century (see e.g. Nickell (1987)). The second line focuses on wages and unemployment, initiated in 1958 by A.W. Phillips in his classic review on the relation between the rate of change of nominal wages and unemployment. Although his approach has been questioned (see e.g. Phelps (1968), Blanchflower and Oswald (1994)), high or persistent unemployment has triggered a lot of research to closely examine wage formation (Drèze and Bean (1990)). A third line is linked to economic policy reforms (Sørensen (1997)). The use of large computer models to examine the impact of policy reforms on the performance of the labour market requires a sound theoretical and empirical underpinning of the role of wages (see e.g. Graafland *et al.* (2001)).

A lot of these studies formulate and estimate wage equations. These describe the impact of institutional and economic factors like taxes, replacement rates, union behaviour, search costs, prices, productivity and unemployment on wage formation. Empirical information is mainly summarized through estimated wage elasticities. This is of major practical importance, as irrespective the theoretical model, it is virtually always possible to derive and compute wage elasticities and compare the results with findings of others. This is the principal aim of this study. We have gathered and computed about 1000 elasticities of pay from some hundred articles, books and working papers. We are not solely interested in mean or median values, but possible differences are also examined: are all estimates of a particular elasticity close to each other? If not, is this due to cross country differences, time dependency, theoretical specification, number of data points, estimation techniques or other factors? And finally, can we derive a 'best guess' of wage elasticities for a particular country on the basis of the collected results?

## 1.2 Other meta studies on elasticities of pay

Nijkamp and Poot (2005) and Clar *et al.* (2007) perform a meta analysis on the unemployment elasticity of pay. Both studies are clearly inspired by the pathbreaking work of Blanchflower and Oswald (1995) on the wage curve. The wage curve describes the responsiveness of individual real wages to changing local market conditions; essentially it is a short run business cycle phenomenon (Nijkamp and Poot (2005), Card (1995)). An inverse relationship between wages and local unemployment rates has been found. The average unemployment elasticity of pay amounts to about -0.10. As Card (1995) argues: the tendency for the wage curve to show up for different kinds of workers, in different economies and at different times suggests that the wage curve may be close to an 'empirical law of economics'. Wage curve elasticities vary, however, between different groups of workers, for different time periods and at different locations.

As outlined in the previous section, our scope is different. We are mainly interested in long run macro elasticities that can be used to calibrate policy simulation models. A second difference is that we focus on eight elasticities rather than just the unemployment elasticity (see section 2.2 and section 3). Yet it may be interesting to compare our results to those reported in the three studies above. Does the 'empirical law of economics' also hold in case of long run macro unemployment elasticities of pay? Are observed values of 'micro' and 'macro' elasticities 'close' to each other? In sections 4.4. and 6.9 we will see that the empirical similarity is remarkable.

## 1.3 Outline of the study

Section 2 describes the global approach, based on a number of guidelines proposed by Stanley (2001). In section 3, I first describe very briefly the various theories behind wage equations, and then we examine how an ideal empirical wage equation would look like and how it can be rewritten using tax and price wedges rather than separate tax and price variables. Finally, an example illustrates the derivation of elasticities from estimated coefficients. Section 4 is devoted to the construction of the meta sample. The selection and construction of regressors that may explain the variation in a specific elasticity is discussed in section 5, and results show up in section 6. This chapter also applies the results of the analysis to compute 'best' values for each type of elasticity. Concluding remarks follow in section 7.

# 2 Five steps to a meta analysis

Meta analysis has become an important tool in evaluating the current flood of conflicting scientific evidence (see e.g. Rothstein *et al.* (2005)). "Meta analysis moves literature reviews away from casual judgements about 'good' studies that deserve attention and 'bad' studies that should be set aside. Instead it provides a replicable statistical framework for summarizing and interpreting the full range of evidence." (Stanley (2001)). The dependent variable is a summary statistic, like a wage elasticity, drawn from each study, while independent variables may include characteristics of the method, design and data used in these studies. It is often argued that a meta analysis will produce an estimate that has broader generalizability than any single study. In addition, such an assessment may even provide further insight (Sutton *et al.* (2001)). Stanley (2001) suggests five steps to successfully conduct a meta analysis:

## 2.1 Step 1: Include all relevant studies from a standard database

A computer search of standard data bases is clearly the place to start. Include all studies, published or not, to reduce potential biases introduced by any non-random selection. The use of a standard search engine is straightforward, but it requires some creativity in selecting the keywords: 'wage equation', 'wage elasticities', 'elasticities of pay', 'empirical wage equation' all yield different results. As the main topic of many articles of interest is not a wage equation as such, but rather inflation or unemployment or NAIRU estimates, I have also put some effort in those directions. In a second stage, I explored all references in the collected articles. Our meta sample contains 155 studies, of which 108 have been used. More details can be found in section 4.

## 2.2 Step 2: choose a summary statistic and reduce the evidence to a common metric

Our relevant statistic is a wage elasticity or equivalently an elasticity of pay. First we have to decide what elasticities of pay we are interested in. We have selected eight elasticities, related to labour productivity, the average income tax rate, the marginal income tax rate, payroll tax, producer price, consumer price, the net replacement rate and the unemployment rate. Direct estimation of these elasticities requires a log linear specification, which is not common in the primary literature. Section 3 deals with the problem of constructing a 'common' metric. Are elasticities obtained from various specifications comparable?

Another problem is the wide variety in wage definitions. From section 4.1 it follows that there are at least 15 definitions, ranging from 'gross yearly wage per employee' to 'ratio of real consumer wage to real post tax benefits'. Section 4.1. elaborates upon this problem and selects an appropriate wage definition (gross yearly wage per employee).

For each study in our sample, I registered two general characteristics: publication year and publication medium (journal, working paper, unpublished). Then, for each separate wage equation, I selected 12 additional characteristics:

(i) country
(ii) aggregate or sectoral estimate
(ii) data type (time series, cross section, panel)
(iii) data frequency
(iv) begin and end year of the sample
(v) wage definition
(vi) transformation of dependent variable (log's, relative change, level, first difference)
(vii) for each wage equation 7 indicators that show whether the other relevant elasticities are included or can be computed;
(viii) 16 dummies that indicate possible restrictions on estimated coefficients in the reported equations (see section 5.2)
(ix) 14 indicators on other possible explanatory variables included (like employment, union density, minimum wage, output gap, profit per employee)
(x) total number of regressors
(xi) dynamic specification indicators (all variables in levels, or all in first differences or some Autoregressive Distributed Lag (ADL, including error correction mechanisms))
(xii) estimation method: Ordinary Least Squares (OLS) or a system estimator?

This information was used to construct moderator variables (see section 2.3 below).

## 2.3 Step 3: choose moderator variables

The moderator variables are the control variables in the meta equation. Two models are frequently used: fixed and random effects models (Sutton et al. (2001)). These methods differ from the common definitions of fixed and random effects models in panel data analysis (e.g. Florax (2002)). The fixed effects model in meta analysis estimates a single common effect applying a Generalized Least Squares method using the inverse of standard errors as weight. As most of the elasticities in the meta sample have been obtained from estimated coefficients, standard errors are generally not available. Therefore I used dummy variables to capture heterogeneity. These variables are linked to main characteristics of studies, not to details. The selection of dummies is outlined in section 5.

An additional problem concerns the distinction between within-study and between-study variation in wage elasticities. It is common in empirical economics for one study to generate more than one estimate of the parameter of interest. Some authors report just the final equation while other publish a number of intermediate results. Selection of one parameter value per study may be misleading and inefficient as additional variation is ignored (Florax (2002)). As is well known, including more than 1 value per study introduces interdependency across the meta sample: some group of elasticities may be correlated with another group as they have been estimated on the same sample and using the same theoretical specification.

In our case there may be an additional correlation as various types of elasticities (e.g. payroll and income taxes) have been obtained from the same study. So the meta sample of payroll tax elasticities may be correlated with the observations on income tax elasticities.

To keep the analysis tractable, if all specifications within a specific study are estimated using the same data set, then I take just one of them. In most cases I prefer the results that the authors regard as ‘best’ (see also Stanley (2001)); in some cases there is an alternative that better meets the goal of the analysis and that cannot be statistically rejected. The possible correlation between different types of elasticities obtained from the same wage equation is accounted for, however. We will discuss this topic in section 5.2.

## 2.4 Step 4: conduct a meta-regression analysis

This is the topic of sections 5 and 6. Section 5.4 specifies the equation to be estimated in its most general form. I prefer the method of Least Absolute Deviations (LAD, see Rousseeuw and Leroy (1987)). LAD estimation produces more robust estimates than Least Squares methods as it is less sensible to outliers in the dependent variable. The total number of meta regressions is eight: one for each type of wage elasticity.

## 2.5 Step 5: Subject the analysis to specification testing

The common method is to estimate all meta equations including as many dummies as possible. The results of the analysis have been used to compute benchmark values for all types of elasticities. I distinguish four country groups, two levels of aggregation and short and long term elasticities. Sensitivity analysis is performed in four ways.

First, benchmark values have been calculated using alternative settings of moderator variables. Do tax elasticities change if we impose that the sum of both price elasticities equals one? Second, statistical tests have been applied to each meta equation to test the joint null hypotheses that some of the moderator variables can be omitted. Benchmark elasticities have also been computed on basis of these restricted LAD estimates. Third, I estimated the equations using Ordinary Least Squares and again computed benchmark elasticities. Finally, a system estimation method was applied to a common sub-sample of some wage elasticities and corresponding benchmark variables were computed.

In addition, I also investigate whether the unemployment elasticity of wages depends on the related level of the replacement rate (Graafland and Huizinga (2001)). A similar test is performed for the possible relation between the replacement rate elasticity and the average level of the unemployment rate.

# 3 Wage equations and elasticities

This chapters starts with a brief overview of common theoretical underpinnings and derivations of empirical wage equations in 3.2. Section 3.3 formulates a general wage equation and introduces some suitable assumptions to derive the desired long run elasticities. Section 3.4 reformulates the equation in case taxes and prices enter the wage equation through wedge variables. Finally section 3.4. gives some examples of transformations needed if elasticities cannot directly be derived from estimated coefficients.

## 3.1 Wage formation in a nutshell

In the standard wage bargaining theory wages result from negotiations between employers' and employees' organizations (see e.g. Layard *et al*. (1991)). Indeed, in the absence of unions, the neoclassical theory predicts that wages are determined by market clearing conditions only. At the other extreme, government measures may fully prescribe wage developments. In practice, usually both employers and unions have an impact on wage setting.

Efficiency in wage bargaining requires that all elements that affect the utility of the agents are subject of the wage bargain (Manning (1987)). As the wage resulting from the bargain has a decisive impact on the employment perspectives of the employees, an efficient bargain will include a contract on wages as well as on employment. The wage-employment solutions lie on the bargaining contract curve, which is defined as the locus of points of tangency between the firm's isoprofit curve and the union's indifference curve. This approach is known as the 'efficient bargaining model' or the 'contract curve model'.

An alternative model is the so-called 'right-to-manage' model. Here unions and employers organizations negotiate on wages only, whereas individual firms have the right to choose employment at desired levels. The outcome of this bargain is clearly not Pareto efficient, but in practice employers organisations may prefer to negotiate on wages only: individual employers should be able to adjust employment to shifts in demand.

In practical applications two possible strategies can be distinguished. A number of authors (e.g. Alogoskoufis and Manning (1988), Brunello and Sonedda (2006), Dolado and Bentolila (1993)) starts with a careful theoretical description of the labour market and the bargaining process and derives relations for wages, prices and (un)employment. These relations serve as a starting point for estimation and testing. This is a fruitful approach in developing a policy evaluation model or if one wants to add specific elements in the bargaining process that are not standard. A second line is to apply a common wage equation from the literature, like the one derived by Layard *et al*. (1991), (see Dolado *et al.* (1986)), Lauer (1999), Nunziata (2005)).

Finally, a number of papers directly specifies a wage equation, inspired by a wage bargaining process but not formally derived from it. This is a common way if one ‘needs’ a wage equation to analyze e.g. wage stickiness, unemployment or inflation. Examples are Carruth and Schnabel (1993), Fritsche *et al*. (2005), Guichard and Laffargue (2000) and Pehkonen (1999).

From these models a number of important wage determinants can be selected. First, labour productivity, which is a decisive factor for long-run real wages. Second, output and consumer prices, to deflate wages or wage costs, while the gap or wedge between both prices is a measure of consumer taxes and prices of final imports. Third, the wedge between the wage bill paid by the employer (wage cost) and the take home wage of the employee; this implies that both payroll taxes paid by the producer and income taxes affect wage setting. Another key variable is the fallback position of employees in case they lose their jobs, usually measured through the replacement ratio (e.g. Pissarides (2000)). And finally, the unemployment rate, either inspired by the traditional Phillips curve approach or by the existence of a wage curve.

From this discussion we select the elasticities reported in Table 3.1 below, similar to the classifications applied by Graafland and Huizinga (1994) and Tyrvainen (1995a).

**Table 3.1 Selected elasticities of gross wages**

| Elasticity | Corresponding variable | Range |
|---|---|---|
| Labour productivity | $q$ | $0 \leq \varepsilon_q \leq 1$ |
| Payroll taxes | $1+s$ | $-1 \leq \varepsilon_{1+s} \leq 0$ |
| Average income retention rate | $1-t_a$ | $\varepsilon_{1-a} \leq 0$ |
| Marginal income retention rate | $1-t_m$ | $\varepsilon_{1-m} \geq 0$ |
| Consumer price | $p_c$ | $\varepsilon_c \geq 0$ |
| Output price | $p_y$ | $\varepsilon_y \geq 0$ |
| Replacement ratio | $\rho$ | $\varepsilon_\rho \geq 0$ |
| Unemployment rate | $u$ | $\varepsilon_u \leq 0$ |

Labour productivity $q$ is defined as the average yearly production per employee (see also the discussion in section 4.1). The replacement ratio $\rho$ is defined as the net income if unemployed over the net wage when employed; $p_c$ and $p_y$ are consumer and output prices.

The next section discusses some practical issues about the use of elasticities from a given wage equation.

## 3.2 Comparing elasticities from different wage equations

A reported wage equation is frequently not log linear in its arguments and hence estimated coefficients are not equal to elasticities. The equation may also have a complex dynamic structure and parameter restrictions may have been imposed during estimation. In addition, in section 4 we will see that there exists a wide variety in definitions of the relevant wage variable.

Indeed, irrespective of the variability of definitions, wage elasticities can almost always be computed, but do they still meet the requirement of a 'common metric'? Are we comparing apples and oranges?

It is obvious that using elasticities obtained from all types of equations and dynamic specifications introduces an additional source of heterogeneity. Even if we transform all elasticities to a common wage definition, for example gross yearly wages per employee, then it probably still matters how they have been measured in the estimated equation.

I use two possible methods to cope with this problem. First through the inclusion of appropriate moderator variables in the meta equations. These dummies capture variation in elasticities due to the definition of the wage variable: hourly wages or yearly wages, real or nominal wages, gross wages or net of income taxes? Second, I use the results of the analyses to compute benchmark values for all elasticities of interest (see section 6). Then I investigate the sensitivity of these values to changes in wage definitions, and to possible restrictions imposed during estimation (e.g. through inclusion of a tax wedge rather than separate payroll and income tax variables).

## 3.3 Towards a common wage definition

Empirical wage definitions are anything but uniform: we observe wages, wage costs, yearly and hourly wages, gross and net wages, real and nominal wages; what is the most suitable definition?

The sample consists of 92 publications. All studies contain one or more wage equations, but there is not much uniformity in the definition of the dependent variable. Table 3.2 summarizes all actual concepts.

The number of definitions is even larger than the table indicates as the indication 'real' may refer to deflation by consumer prices, output prices or the GDP price deflator. From a theoretical point of view, a suitable definition of wage is the hourly wage rate per worker. This fits to the definition of labour productivity as the hourly production per employee. This wage definition is related to 53 reported equations only. Therefore I preferred a more practical definition: the gross yearly wage per employee. Conversion of hourly wages to yearly wages requires the number of hours worked (which may change from year to year) as well as extra allowances (for overtime work or holidays, for example).

Technical details are summarized in Appendix A. It discusses the computation of elasticities from generally specified wage equations.

**Table 3.2 Wage definitions**

| Definition | Number of cases |
|---|---|
| Gross wage per employee | 91 |
| Gross wage costs per employee | 27 |
| Real gross wage per employee | 21 |
| Real gross wage costs per employee | 46 |
| Net wage per employee | 37 |
| Gross hourly wage | 1 |
| Gross hourly wage costs | 1 |
| Real gross hourly wage costs | 8 |
| Real net hourly wage | 43 |
| Real consumer wage | 10 |
| Ratio of real consumer wage and real post tax benefits | 2 |
| Nominal monthly wages | 1 |
| Real monthly wages | 7 |
| Quarterly gross wages per employee | 1 |
| Nominal unit Labour costs | 6 |
| Total | 296 |

# 4 Construction of the meta samples

## 4.1 Introduction

In section 4.2 we discuss the selection of useful papers. The remaining sections describe the meta sample: 4.3 highlights the representation of various countries and country groups and finally section 4.4 summarizes the data by type of elasticity.

## 4.2 Selection of relevant papers

The base collection contains 116 publications. The list is not exhaustive but it covers time series, cross section and panel data studies on countries and firms, published either in books, official journals or as working or conference paper. They have been collected by scanning electronic data bases of journals and publications of research institutes and conferences. First, I have used Google Scholar to search on 'wage equations', and 'wage elasticities'. Soon it became clear that many wage equations were estimated to study unemployment, inflation or the impact of tax measures. So I also tried al possible combinations of these items. In a second round also relevant cited papers were examined. In the end 92 papers proved to be useful for our purpose. What is 'useful'?

The main scope is the collection of elasticities of the macro wage equation, rather than those of the individual earnings equation. Here the qualification 'macro' does not necessarily refer to average wage per worker in the whole economy; it may also be the outcome of a (decentralized) bargaining process between employers and unions in a specific production sector. Individual earnings equations on the other hand link the wage of a specific person to his or her level of education, working experience, age, marital status, union membership, and other variables. Although these earnings may also very well be influenced by regional or national demand factors (among which the unemployment rate is by far the most popular) their pattern is hardly even explained by payroll or income taxes, welfare benefits or output prices. Individual earnings equations are very useful in estimating wage curves (see also section 1). I decided not to use the unemployment elasticities of pay from these equations in order to examine possible differences between 'individual' and 'macro' elasticities.

Another selection criterion is the computational effort needed to extract the desired elasticities. In a number of cases they could not be computed from data provided by the authors as very specific additional data were needed. For example: time series of regional or sectoral unemployment rates, average opportunity wage outside the manufacturing industry or average income tax rates for specific groups.

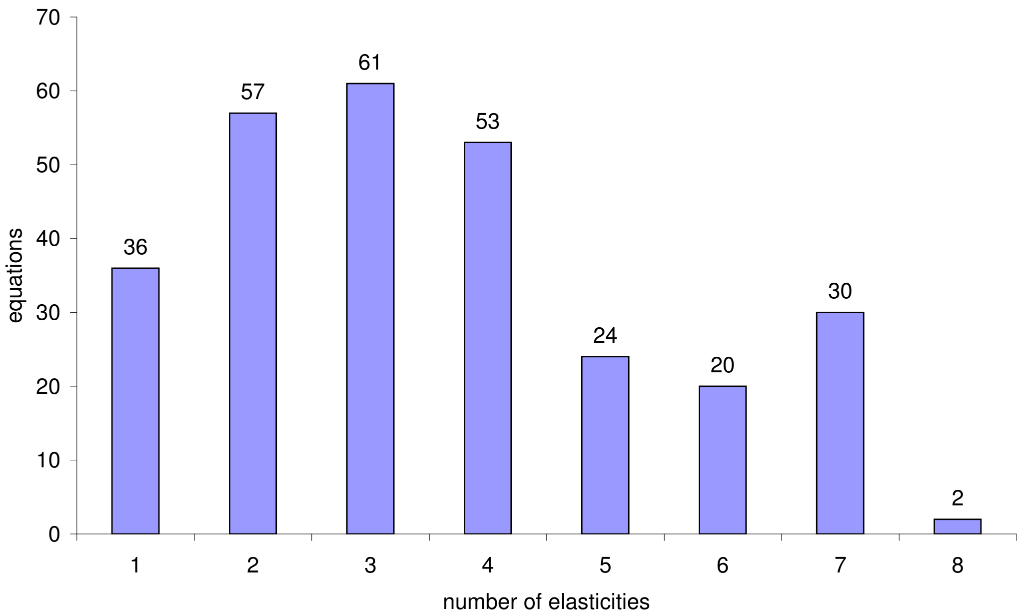
What about short and long term elasticities? If both are reported, I have used the long term values. Some authors however express the wage variable in first differences, differences in the log of wages or percentage changes. The related elasticities can be interpreted as short run values. These elasticities are also included in the meta regressions.

## 4.3 Construction and completeness

Once the publications were selected, I generated data vectors for each type of wage elasticity by stacking observations in alphabetical order. So the first element in each vector refers to the first wage equation in the first study. This method has the strong advantage that the i-th value of all elasticity vectors refers to a common equation. If a publication yields less than 8 elasticities, missing values are included as Not Available (NA). Consequently all vectors of elasticities have equal length.

Figure 4.1 classifies the estimated wage equations by the number of included elasticities in demand. It appears that almost 25% of all equations include at most 2 of the desired elasticities. Of course this does not imply that the equation at hand only contains two regressors, but nevertheless possible interactions between the various elasticities may not be fully taken into account.

**Figure 4.1 Classification of estimated equations by number of elasticities**




## 4.4 Sample characteristics

Table 4.1 illustrates the distribution of estimated elasticities by type and over countries.

**Table 4.1 Number of computed elasticities by type and country**

| Country | $\varepsilon_q$ | $\varepsilon_{1+s}$ | $\varepsilon_{1-a}$ | $\varepsilon_{1-m}$ | $\varepsilon_c$ | $\varepsilon_y$ | $\varepsilon_\rho$ | $\varepsilon_u$ | total |
|---|---|---|---|---|---|---|---|---|---|
| Australia | 2 | 2 | 2 | 1 | 5 | 2 | 1 | 4 | 19 |
| Austria | 5 | 1 | 1 | 0 | 2 | 3 | 0 | 6 | 18 |
| Belgium | 4 | 1 | 2 | 0 | 3 | 2 | 0 | 5 | 17 |
| Bulgaria | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 |
| Canada | 4 | 2 | 3 | 1 | 3 | 3 | 1 | 7 | 24 |
| Denmark | 6 | 4 | 1 | 1 | 2 | 5 | 5 | 10 | 34 |
| Finland | 8 | 21 | 19 | 1 | 18 | 23 | 10 | 13 | 113 |
| France | 10 | 5 | 6 | 1 | 9 | 9 | 2 | 14 | 56 |
| Germany | 14 | 6 | 5 | 1 | 7 | 12 | 2 | 17 | 64 |
| Hungary | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 |
| Ireland | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 4 | 16 |
| Italy | 8 | 5 | 6 | 1 | 4 | 7 | 0 | 12 | 43 |
| Japan | 5 | 3 | 2 | 1 | 3 | 3 | 0 | 5 | 22 |
| The Netherlands | 39 | 32 | 36 | 1 | 29 | 32 | 27 | 39 | 235 |
| New Zealand | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 2 | 5 |
| Norway | 5 | 7 | 5 | 0 | 5 | 9 | 5 | 14 | 50 |
| Poland | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 4 |
| Portugal | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 6 |
| Romania | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 |
| Spain | 6 | 5 | 4 | 1 | 5 | 6 | 6 | 10 | 43 |
| Sweden | 7 | 8 | 9 | 2 | 7 | 11 | 2 | 14 | 60 |
| Switzerland | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 3 |
| UK | 10 | 11 | 12 | 2 | 7 | 13 | 8 | 20 | 83 |
| USA | 7 | 6 | 5 | 1 | 6 | 8 | 2 | 12 | 47 |
| Country groups | 4 | 6 | 10 | 2 | 6 | 1 | 2 | 5 | 36 |
| Nordic countries | 26 | 40 | 34 | 4 | 32 | 48 | 22 | 51 | 257 |
| Anglo Saxon countries | 26 | 24 | 25 | 6 | 23 | 28 | 13 | 49 | 194 |
| The Netherlands | 39 | 32 | 36 | 1 | 29 | 32 | 27 | 39 | 235 |
| Other countries | 58 | 32 | 36 | 7 | 45 | 44 | 12 | 84 | 318 |
| Total | 149 | 128 | 131 | 18 | 129 | 152 | 74 | 223 | 1004 |

Roughly spoken, there are 3 main country groups: the Nordic countries (Norway, Sweden, Denmark, Finland), Anglo-Saxon countries, and other European countries with Germany, France, the Netherlands and Italy as main representatives. A number of elasticities refers to pooled estimates for country groups, like Nordic Countries or (a sample of) OECD countries. The table also shows that the sample is neither complete (not all elasticities are available for all countries) nor uniform. The number of elasticities corresponding to The Netherlands (235) seems extremely high; it must be noted that 140 of these have been obtained from one publication: Graafland and Verbruggen (1993) estimate on average 7 elasticities for 20 production sectors.

Table 4.2 supplies summary statistics of the meta sample by type of elasticity. Estimates of the unemployment elasticity of pay are most abundant while the elasticity of the marginal retention rate is relatively scarce.

**Table 4.2 Elasticities of pay by type**

| | Number | Sample mean | Sample median | Standard error | Minimum | Maximum |
|---|---|---|---|---|---|---|
| Labour productivity ($q$) | 146 | 0.875 | 1 | 0.199 | 0.250 | 1.121 |
| Payroll tax($1+s$) | 138 | – 0.659 | – 0.720 | 0.323 | – 1 | 0 |
| Average retention ratio ($1-t_a$) | 131 | – 0.390 | – 0.368 | 0.277 | – 1 | 0.100 |
| Marginal retention ratio ($1-t_m$) | 18 | 0.226 | 0.200 | 0.245 | – 0.120 | 0.650 |
| Producer price ($p_y$) | 152 | 0.725 | 0.790 | 0.273 | 0 | 1.140 |
| Consumer price ($p_c$) | 129 | 0.657 | 0.774 | 0.363 | 0 | 1.090 |
| Replacement ratio (ρ) | 74 | 0.349 | 0.322 | 0.274 | 0 | 1.080 |
| Unemployment rate ($u$) | 223 | – 0.089 | – 0.064 | 0.093 | – 0.498 | 0.160 |
| Total | 1011 | | | | | |

The number of observations relating to The Netherlands (235) seems extremely high. Inspection of the meta samples shows that this is likely due to the inclusion of the study of Graafland and Verbruggen (1993), who estimate wage equations for some 20 production sectors in The Netherlands, resulting in 140 wage elasticities. Some numbers in table 4.3 appear as integers indicating that their values have been fixed a priori or restricted in the reported equation. Section 5.2. discusses how to account for the impact of these econometric restrictions on reported elasticities of pay.

Figures 4.2 to 4.8 illustrate the distribution of the eight types of elasticities (excluding the wedge variables). Numbers at the horizontal axes are midmark values. In each diagram 3 vertical lines are drawn. The central line indicates the mean value of the elasticity; the other two are one standard deviation away from the mean value. There is a lot of variation in the diagrams: the elasticities of wages with respect to labour productivity and the unemployment rate are rather concentrated around their mean values. The distributions of the elasticities of tax rates on the other hand tend to be more dispersed.

From figure 4.2 it can be seen that more than 50% of the labour productivity elasticities in the sample was a priori set at a value of 1. Despite of this, the sample mean is about 0.86, which implies that the mean value of the free estimates is roughly 0.7. The data do not suggest an unambiguous reason for this difference. All relevant studies use time series data; in some cases low values correspond to specific countries (Drèze and Bean (1990), Fritsche et al. (2005), Guichard and Laffargue (2000)), but the data also indicate that short run elasticities tend to be somewhat smaller than long run values.

**Figure 4.2 Labour productivity elasticity of wages**

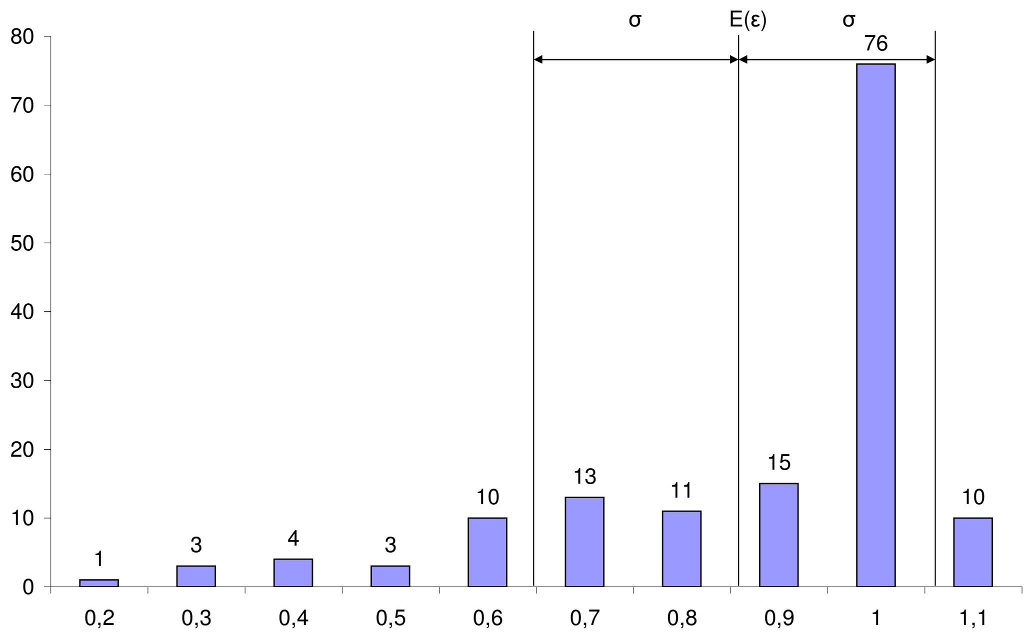



**Figure 4.3 Payroll tax elasticity of wages**

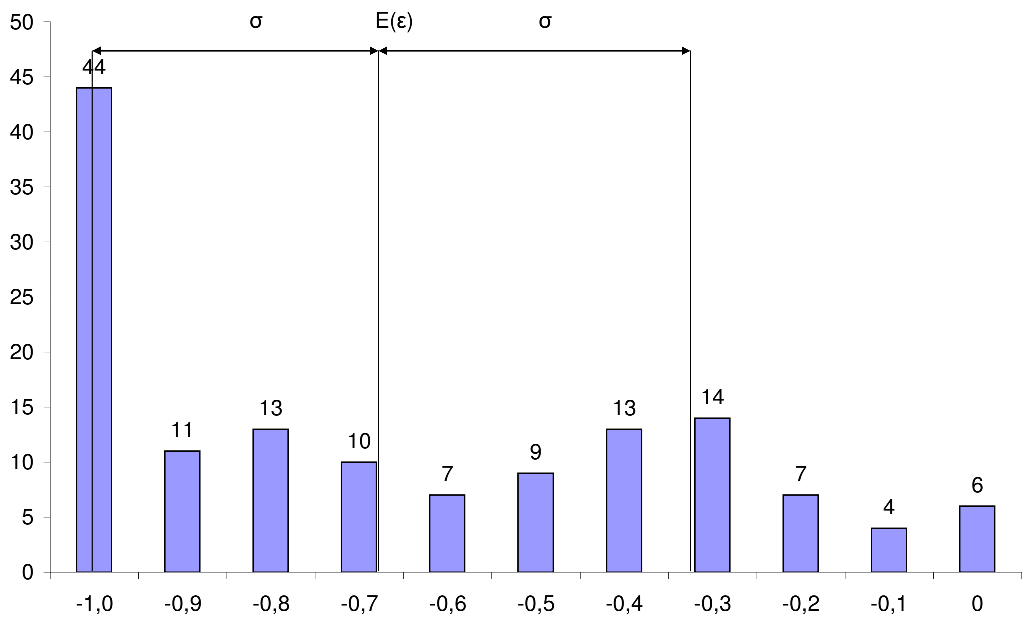
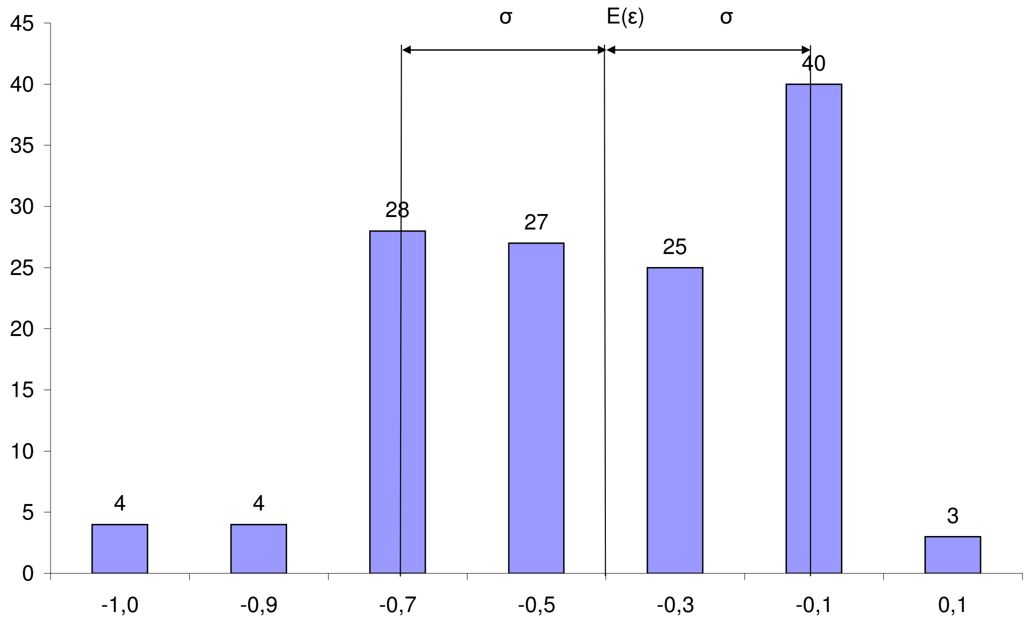



Figure 4.3 shows that 40 payroll tax elasticities have been set to −1 a priori; most of these correspond to wage equations in which the dependent variable is expressed as wage cost per employee. Apart from these values, the distribution is rather uniform. The sample mean of

– 0.67 indicates that 33% of a payroll tax increase is borne by the producer; 67% of the burden is shifted on to the employee. It is reasonable to assume that this process takes some time to settle; hence the short run elasticity may differ from the long run value. Furthermore, 41 out of 128 elasticities were computed from tax wedge elasticities; the sample mean of these restricted estimates is about – 0.60, which implies that the mean of the unrestricted elasticities is about – 0.72. This difference is not that large (some 40% of the standard error) but it may be significant.

From figure 4.4 it follows that the values of the elasticity of the average retention rate are roughly between – 0.7 and – 0.1. As in case of producer taxes, we expect short and long run values of the elasticity to differ. The direction of the adjustment process will be opposite, however: the impact on the long run will be smaller (in absolute value) than the sort term elasticity. The sample mean of the 41 values extracted from price wedge estimates is virtually the same as the overall sample mean of – 0.39. Therefore in this case we expect that the impact of the restrictions is small and insignificant.

**Figure 4.4 Average retention rate elasticity of wages**




The sample of marginal retention rate elasticities contains 18 observations only, of which 10 were obtained from Tyrväinen (1995b); 5 of these were put to zero after a statistical test. Another 4 elasticities are in the range 0.5 - 0.6. The pooled estimation of Brunello and Sonedda (2007) however yields very small values. It remains to be seen whether any conclusions can be drawn from the regressions.

**Figure 4.5 Marginal retention rate elasticity of wages**

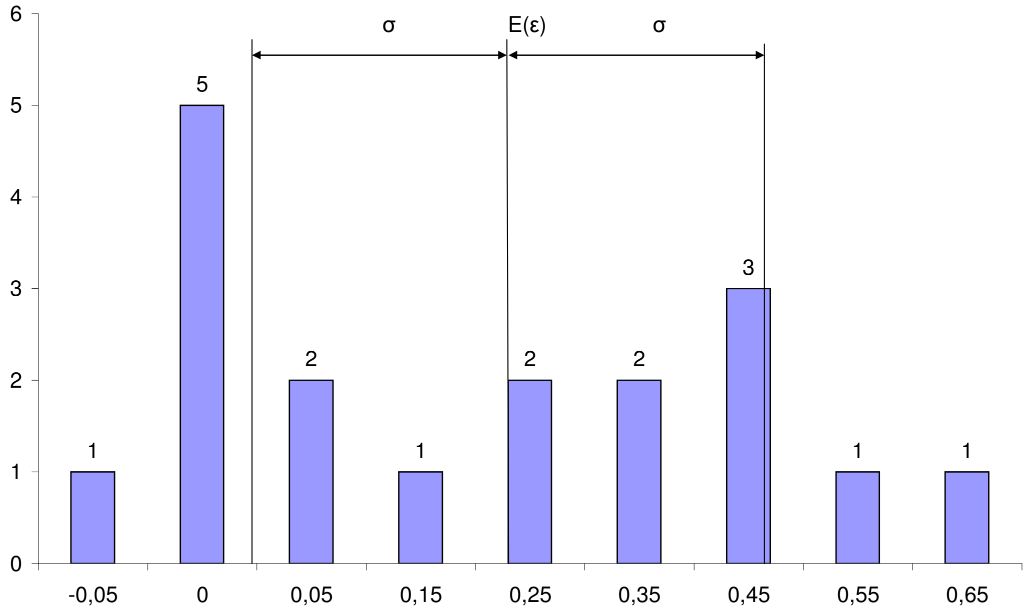



**Figure 4.6 Producer price elasticity of wages**

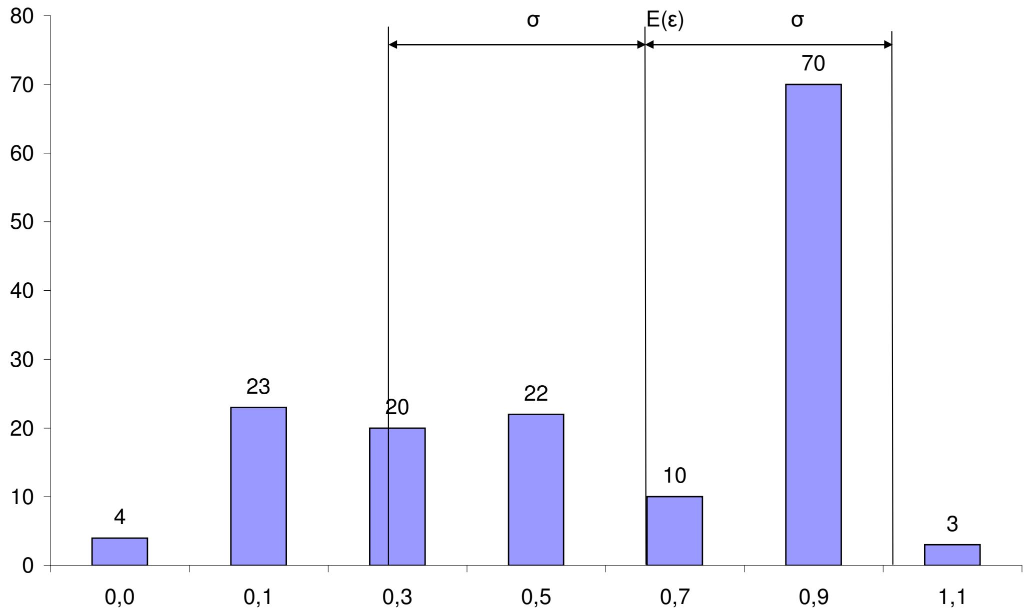


**Figure 4.7 Consumer price elasticity of wages**

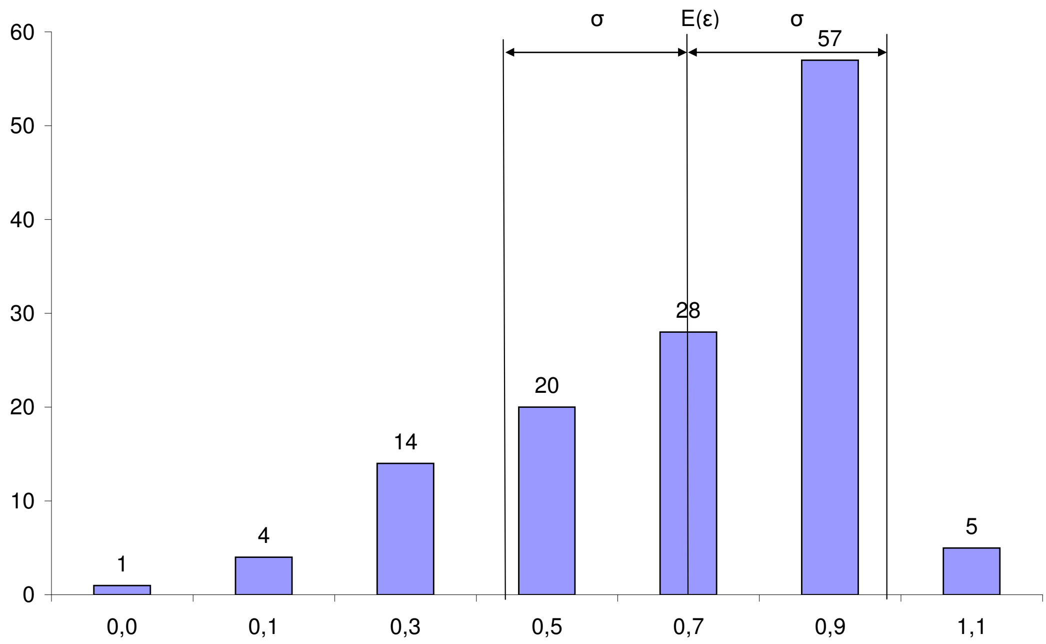



**Figure 4.8 Replacement rate elasticity of wages**

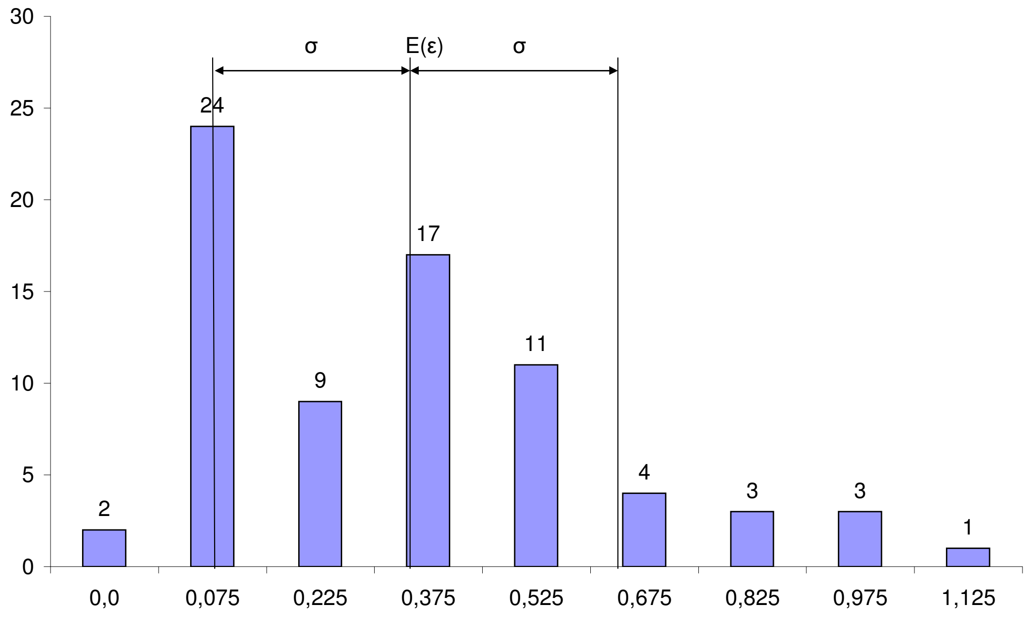
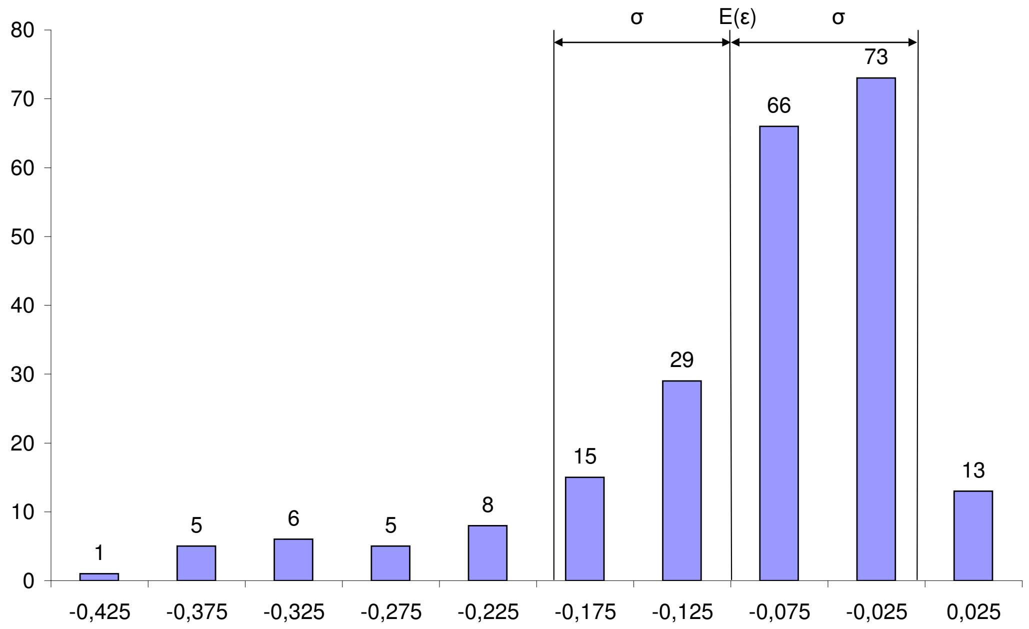



Figure 4.6 and 4.7 display price elasticities of the wage rate. Many publications estimate real wage equations; in these cases the output price or the consumer price is used as deflator and the corresponding wage elasticity is 1 by assumption. This can be seen from the figures: many values are in the interval (0.8, 1.0]. In case of $p_y$ 54 elasticities are fixed to 1 by applying $p_y$ as wage deflator; in figure 4.6 25 values of the consumer price elasticity are set to 1. Restrictions also play a crucial role here: 26 producer price elasticities and 27 consumer price wage

elasticities were obtained from regressions that include the price wedge or a combined price wedge and tax wedge. What do we expect from the meta-analysis? There may be a difference in price elasticities obtained from nominal and real wage regressions. In addition, equations that incorporate the role of prices through a wedge only may yield results that differ from freely estimated elasticities. Finally, as both prices are interrelated, one may expect that it makes a difference whether both are included in the wage equation or just one of them.

Finally, figure 4.9 shows the values of the unemployment elasticity of pay. Almost 85% of the elasticities differs less than one standard error from the sample mean. This sample mean is pretty close to the results reported by Blanchflower and Oswald (1994), Nijkamp and Poot (2005) and Clar *et al.* (2007). This is remarkable, as most of our estimates have been obtained from long run macro or sectoral wage equations while the well known wage curve relates real individual earnings to local labour market conditions. Does this support the 'natural constant' hypothesis (Card (1995))? We will explore this further on.

**Figure 4.9 Unemployment rate elasticity of wages**



# 5 Set-up of the meta analysis

## 5.1 Econometric modelling

The meta sample consists of 8 series corresponding to 8 types of estimated elasticities of pay. The aim is to explain the variation within each series using characteristics of studies from which the elasticities have been obtained or computed. This is done by using dummy variables that cover these characteristics adequately. The type of dummy to be included depends on the source of variation that we expect to play a role.

Define the set A: $\{q, 1+s, 1-t_a, 1-t_m, p_y, p_c, \rho, u\}$ that contains all economic variables that correspond to the wage elasticities of interest. The meta sample contains 8 vectors of elasticities $\varepsilon_i, i \in A$ . The length of all vectors is the number of included wage equations. The variation within each vector $\varepsilon_i$ is explained by a vector of general constants $\alpha_{i0}$ and a set of $N_1$ dummy vectors $d_j$ (value 0 or 1). We also add $N_2$ dummy vectors $e_k$ that cover differences across elasticities due to restrictions on estimated parameters in the reported wage equations. Finally, the $N_3$ vectors $x_j$ represent all possible other explanatory variables:

$$\varepsilon_i = \alpha_{i0} + \sum_{j=1}^{N_1} \alpha_{ij} d_j + \sum_{k}^{N_2} \phi_{ij} e_k + \sum_{m=1}^{N_3} \lambda_{im} x_m + v_i \quad i = 1,\ldots,8 \tag{5.1}$$

where $v_i$ is a vector of disturbance terms. In the remaining subsections we introduce possible dummies $d_j$ and $e_k$ and other exogenous variables $x_m$.

## 5.2 Selection of dummy variables

### Country dummies

One reason why estimated elasticities vary across countries is the existence of institutional differences. These may concern the tax schedule, the organisation of the social security system, the relative size of various production and service sectors and so on. All these sources of inequality are usually summarized in country specific dummy variables. From table 4.2 however it follows that the distribution of wage equations over countries is far from uniform. Therefore to begin with we opt for clustering and introduce dummy variables for the Nordic countries, Anglo-Saxon countries, The Netherlands and other countries.

### Time dummies

A large share of the studies uses time series, from as early as 1952 (Alogoskoufis and Manning (1988)) until recent years. Elasticities may very well have changed during this 55 year period.

To capture possible variations over time we introduce time dummies for two periods: 1950 - 1969 and 1990 - 2008.

### Data and sector dummies

We add a dummy that indicates whether estimates have been obtained from time series analysis or from other methods (cross section or panel data). The distinction between time series and data panels is not always transparent. A cluster of observations on 4000 firms during 3 years is clearly a panel, but what about a country panel that contains data from 20 countries over a time horizon of 25 years? Therefore, if the time dimension is much smaller than the cross section dimension, we consider the data to be a panel.

It may also make sense to distinct elasticities obtained from sectoral and those computed from macro wage equations.

### Wage bargaining and union density

We want to discriminate between wage equations that have been derived from a theoretical model that describes wages as the outcome of a bargaining process between employers and unions, and other models. The distinction is not always clear however, as a number of authors does not explicitly derive their equation from a bargaining concept but just indicate that 'an equation type like ours can formally be derived from...'. In such cases we treat the estimates 'as if derived from'.

A related dummy indicates whether a specific elasticity has been obtained from an equation that includes union density as an explanatory variable, or not. Union density serves as a measure for bargaining power; it is defined as the number of union members relative to the total number of employees.

### Selection bias?

Card and Krueger (1995) argue that journal editors are possibly biased towards acceptation of papers that contain statistically significant results. In this case however, that argument won't stand up. An important share of the studies examined is not primarily concerned with wages, but rather unemployment. Wage elasticities are often not even reported or computed, let alone that standard errors can be obtained.

Yet it may be useful to make a distinction between peer reviewed articles and working papers. Studies that contain inconclusive or unexpected results, or analyses that just apply a known specification to other data or different countries are seldomly send in to or accepted by scientific journals. It is not clear a priori whether this biases reported results, but to take a possible impact into account, we introduce a publication dummy that equals 1 only if a study has been published in a refereed scientific journal.

### Single equation and system estimation

A number of studies estimates single wage equations, some consider a system of wage and price equations or employment and wage equations. We introduce one dummy to indicate whether a single equation estimation method has been used (usually OLS) or a system estimation technique.

### Dynamic specification

The dynamic specification of the reported equation will affect estimated elasticities. We distinguish between elasticities obtained from equations in which all variables have been expressed as first differences or percentage changes, those computed from level equations only and estimates obtained from autoregressive distributed lag (ADL) equations. The latter contain both endogenous and exogenous variables in levels and (first) differences. Error correction models are a particular case of this type. Equations formulated in first differences yield short run elasticities only; this enables us to investigate whether the latter differ from long term elasticities.

If a wage elasticity can be obtained, then by definition the 3 dummies are interrelated: their sum equals 1. As the first difference dummy indicates possible differences between short and long term elasticities, I preferred to use this dummy with either one of the two remaining ones.

### Restriction dummies

Estimated values of wage elasticities not only depend on wage definitions and sample characteristics, but also on the number and kind of all explanatory variables included in the reported regression. Ideally, long run specifications are log linear but even so, not all estimated equations include all desired regressors (see also figure 4.1). An important point to note is note is that a number of elasticities has been fixed a priori at a value of 1. Furthermore, there are cross elasticity restrictions: for example, inclusion of the tax wedge into an equation implicitly restricts the coefficients of the payroll tax factor $(1+s)$ and the average income retention rate $(1-t_a)$ to be equal (see also Appendix A). To capture all these possible sources of variation I use in each estimated equation an indicator that has 4 possible values for all relevant elasticities: not included, free estimate, restricted estimate or fixed coefficient. A restriction imposed after estimation and testing has been treated as a free estimate.

The following example contains two important cases that need special attention. Suppose we have specifications like:

$$\ln\frac{W}{p_c} = \ldots + \beta\ln\frac{p_c}{p_y} + \ldots$$

$$\ln W(1+s) = \ldots + \alpha\ln\frac{1+s}{1-t_a} + \ldots \tag{5.2}$$

In the first equation of (5.2) the consumer price coefficient is both fixed (to 1) as it is used as a deflator and restricted (from the wedge variable). In this case the overall judgement is 'restricted' as its value equals $\beta - 1$ and the coefficient of $p_y$ equals $-\beta$ . The same holds for the payroll tax 1+*s* in the second equation of (5.2). Similar cases occur if $p_y$ is used as deflator, or if wages net of income taxes appear on the left hand side. Table 5.1 gives an example.

**Table 5.1 An example of restriction dummies**

| Elasticity | Indicator | F dummy | R dummy | C dummy |
|---|---|---|---|---|
| Labour productivity | fixed | 0 | 0 | 1 |
| Payroll taxfactor (1+*s*) | restricted estimate | 0 | 1 | 0 |
| Average income retention rate ($1-t_a$) | restricted estimate | 0 | 1 | 0 |
| Marginal income retention rate ($1-t_m$) | not included | 0 | 0 | 0 |
| Producer price ($p_y$) | fixed | 0 | 0 | 1 |
| Consumer price ($p_c$) | not included | 0 | 0 | 0 |
| Replacement rate (ρ) | free estimate | 1 | 0 | 0 |
| Unemployment rate (*u*) | free estimate | 1 | 0 | 0 |

In table 5.1 the indicator column shows that in the reported wage equation the coefficients of labour productivity and the producer price are a priori fixed (C dummy equals 1), parameter estimates corresponding to producer and average income taxes have been restricted (their R dummy is 1), the marginal income retention rate and consumer price are missing and coefficients for the replacement and unemployment rate have been estimated freely (F dummy = 1). This method enables to classify all reported equations that supply wage elasticities of all types. The sum of the 3 dummies (F, R and C) is either 0 (if the elasticity is not observed) or 1. If the sum of the F, R, and C dummies equals 1, I have deleted the F dummy: a free estimate is the reference case.

**Exogenous variables**

Some authors (Graafland and Huizinga (1999), Peeters and den Reijer (2001, 2002), Kranendonk and Verbruggen (2006)) argue that the unemployment rate elasticity of pay depends on the level of the replacement ratio and vice versa. For instance, they suggest that a higher unemployment rate reduces the replacement rate elasticity of pay while on the other hand the impact of unemployment on wages is lower when replacement rates are high. This mutual dependence can be taken into account by adding the corresponding sample averages of unemployment and replacement rates as explanatory variables in the meta regressions for the elasticities of the replacement ratio and unemployment rate, respectively. Hence, in 2 equations we add 1 explanatory variable $x_m$ (see equation 5.1).

## 5.3 Overview and use of Dummy variables

### Overview

Table 5.2 lists all defined dummy variables. Restriction dummies not included in the table have at most 5 nonzero values in the complete sample. The remaining dummies have at least 21 nonzero values.

**Table 5.2 Overview of Dummy variables**

| Dummy variable | Condition, value =1 |
|---|---|
| Country dummy The Netherlands | The Netherlands |
| Dummy Anglo Saxon countries | UK,USA, Canada, Australia, New Zealand |
| Dummy Nordic countries | Denmark, Finland, Norway, Sweden |
| Publication dummy | Publication in journal |
| Time series dummy | Based on time series data |
| System estimator dummy | Use of simultaneous equation techniques |
| Bargaining dummy | Specification based on wage bargaining model |
| Union density | If included in source equation |
| First difference estimation | All variables in source equation in first differences |
| Dummy level estimation | Source equation formulated in level variables |
| Autoregressive Distributed Lag dummy | Source equation estimated in ADL format |
| Sector dummy | Sectoral wage equations |
| Time dummy 50-60 | If mid sample year in time span 1950 - 1969 |
| Time dummy 90-08 | If mid sample year in time span 1990 - 2008 |
| F dummy all relevant elasticities | If specific elasticity is freely estimated in the source equation |
| R dummy producer tax | If restricted in source equation |
| R dummy average retention rate | If restricted in source equation |
| R dummy consumer price | If restricted in source equation |
| R dummy producer price | If restricted in source equation |
| C dummy labour productivity | If fixed in source equation |
| C dummy producer tax | If fixed in source equation |
| C dummy consumer price | If fixed in source equation |
| C dummy producer price | If fixed in source equation |

### Correlation between dummy variables

The larger the number of dummies, the better we may be able to explain the variation in computed elasticities, if only they are ‘sufficiently’ independent. This depends on the specific data sample. It is possible that a dummy takes only one value in the sample that is relevant for a certain elasticity. Some dummies may be (nearly) perfectly correlated for all observations in a certain sample, while their overall correlation in the complete sample is modest. As the total number of possible dummies exceeds 30, series should be sufficiently long. Therefore, it is not always possible to explore the full set of dummy variables.

## 5.4 Estimation: specification and technique

### Specification

We rewrite equation (5.1) by explicitly introducing the dummies discussed above:

$$\varepsilon_i = \alpha_{i0} + \sum_{j=1}^{13} \alpha_{ij} d_{ij} + \sum_{k=1,k\neq i}^{8} \beta_{ik} F_{ik} + \sum_{k=1}^{8} \gamma_{ik} R_{ik} + \sum_{k=1}^{8} \delta_{ik} C_{ik} + \lambda_{i1}\overline{\rho} + \lambda_{i2}\overline{u} + v_i \quad i \in A \tag{5.3}$$

in each equation we have a general constant, 13 dummy vectors $d_j$, 7 F dummy vectors, 8 R and C dummy vectors (see table 5.3). In each equation at least one of the λ coefficients is zero. Each element of the vectors of the replacement rate $\overline{\rho}$ and the unemployment rate $\overline{u}$ equals the sample average of the reported study. This is a rather simple model: in 2 out of the 8 equations we use 1 exogenous variable; all other regressors are dummies.

From the estimated coefficients one may obtain a 'best guess' for each wage elasticity. To this end equation (5.3) can be applied with all parameters replaced by their estimated values. Of course, one has also to consider the preferred values of the dummy variables. Should they be set at 0 or 1 or is it better to take a sample mean? We will return to this point in section 6.3.

### Estimation technique

The most straightforward method to estimate equation (5.3) is Least Squares (OLS or GLS), which can easily be implemented in a program like Eviews. A drawback however of Least Squares methods is the strong impact of outliers on estimated coefficients and standard errors. Preliminary regressions confirm this expectation.

The first alternative is weighted least squares. It is common to use reported standard errors as weights but, as noted earlier, in many cases they are not available. Therefore I have constructed a common measure of the relative robustness of reported and computed elasticities. This weight combines 3 aspects of the elasticities: (i) the number of data points relative to the number of estimated parameters in the reported equation, (ii) the number of alternative specifications tested and (iii) the number of explanatory variables in the reported equation. Each aspect is valued on a 1 to 5 scale and individual scores are simply added. The results however, were very similar to those of standard OLS regressions.

Therefore it may be better to use more robust techniques, like Least Absolute Deviation (LAD). The LAD technique belongs to the family of Quantile Regression Methods (Koenker and Hallock (2001)). This estimator minimizes the sum of absolute deviations from the median value. The latter is not always unique and the same holds for the LAD estimator. The LAD estimator can be interpreted as a special case of GLS as it uses the inverse of the absolute residuals as regression weights (e.g. Judge *et al* (1985), section 7.4). As Rousseeuw and Leroy (1987) argue, its application yields a considerable gain in robustness, because the estimator is less sensible to outliers in the dependent variable than LS estimators. It's vulnerability to outliers in the independent variables will not be a problem here as the values of all our moderator variables are in the interval (– 1, 1) (see chapter 5).

Judge *et al* (1985) report some distributional properties of the LAD estimator $\hat{\beta}_M$ (section 7.4). $\hat{\beta}_M$ is the maximum likelihood estimator if the disturbances follow a two-tailed exponential distribution with density function:

$$f(u_t) = \frac{1}{2\lambda}\exp\left(-\frac{|u_t|}{\lambda}\right) \tag{5.4}$$

This density function is more peaked than the normal distribution and has fatter tails, but still has a finite variance. Under the assumption that (1) $u_t$ are independent, identically distributed random variables with a continuous distribution function $F$ and median zero, and (2) $\lim_{T\to\infty} T^{-1}X'X = Q$ is a positive definite matrix, Bassett and Koenker (1978) show that $\sqrt{T}(\hat{\beta}_M - \beta)$ is asymptotically normal with mean zero and covariance matrix $w^2Q^{-1}$, where $w^2$ is the asymptotic variance of the sample median from samples with distribution $F$. As Judge et al (1985) note, the result of Basset and Koenker (1978) implies that the LAD estimator is asymptotically more efficient than the LS estimator for all distributions where the median is superior to the mean as an estimator of location.

As a measure of the goodness of fit we apply a statistic suggested by Koenker and Machado (1999):

$$R^1 = 1 - \frac{\hat{V}}{\overline{V}} \tag{5.5}$$

where $\hat{V}$ and $\overline{V}$ are the objective functions of the full model and the restricted model that contains a constant only.

The software package Eviews computes all relevant statistics, including asymptotic standard errors using a Huber Sandwich method (see e.g. Freedman (2006)). Apart from these standard errors, we will report p-values. The latter denote the minimum size for which the null hypotheses that a coefficient equals zero would still be rejected. If the p-value is smaller than the significancy level α of the test, the null hypothesis is rejected (Verbeek (2003), page 31). For joint testing the hypothesis that k coefficients are zero, Eviews reports a Quasi Likelihood

Ratio (QLR) test, which is asymptotically $\chi^2(k)$ distributed with k the number of restrictions imposed by the null hypothesis (Koenker and Basset (1982)). Additional technical details can be found in chapter 31 of the Eviews6 manual.

# 6 Overview of results

## 6.1 General approach

In each meta regression I use the complete set of dummy vectors. To prevent spurious correlations, dummies that only have nonzero values in less than 10% of the sample have been excluded from the regression.

Section 6.2 presents a global overview of the results. A detailed description can be found in appendix C. This appendix also discusses results from Ordinary Least Squares regressions. Section 6.3 computes benchmark values for all types of elasticities using estimated coefficients and specific values of dummy variables. Section 6.4 explores the possibility to compute benchmark elasticities for wage equations that contain a wedge variable. Finally, section 6.5 discusses benchmark elasticities obtained from system Least Squares regressions. These take possible correlations between elasticities obtained from the same study into account.

## 6.2 Summary of outcomes

Tables 6.1 and 6.2 summarize regression results.

**Table 6.1 Elasticities of pay: signs of coefficients and general statistics**

| | Elasticity of pay corresponding to: | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $q$ | $1+s$ | $1-t_a$ | $1-t_m$ | $p_c$ | $p_y$ | ρ | $u$ |
| Constant | ++ | – | – | + | ++ | ++ | – | – |
| The Netherlands dummy | – | – | + | + | + | – | + | – |
| Anglo Saxon dummy | + | + | – | + | – | + | – | ++ |
| Dummy Nordic countries | + | – | – | + | – | + | – | – |
| Publication dummy | + | + | – – | | + | – | + | – |
| Time series dummy | | – | – | | – | – | ++ | – |
| Hourly wage dummy | + | – | + | | ++ | – | + | + |
| Single equation estimator | + | – | + | | + | + | – | + |
| Bargaining dummy | – | – | – | | + | – | + | + |
| Union density | | – | | | | – | | |
| First difference estimation | – | ++ | – | | + | – | | |
| Level estimation | + | – | + | | – | – | – | – |
| Sector dummy | + | + | + | | + | – | + | + |
| Time dummy 1990-2008 | | | | | | – | | + |
| Volume unemployment rate | | | | | | | + | |
| Pseudo $\overline{R}^2$ | 0.169 | 0.413 | 0.169 | – 0.008 | 0.304 | 0.607 | 0.119 | 0.021 |
| Mean value | 0.875 | – 0.659 | – 0.390 | 0.226 | 0.725 | 0.657 | 0.349 | – 0.089 |
| Observations | 146 | 138 | 131 | 18 | 129 | 152 | 74 | 223 |

The tables display the signs of the estimated coefficients. Coefficients with p-values above 0.10 have been single marked, if the p-values are smaller than 0.10, double marks have been used. The $\overline{R}^2$ statistic reported is a pseudo $\overline{R}^2$ (section 5.3, formula (5.5), corrected for degrees of freedom).

**Table 6.2 Elasticities of pay: coefficients of restriction dummies**

| | Elasticity of pay corresponding to: | | | | | | |
|---|---|---|---|---|---|---|---|
| | $q$ | $1+s$ | $1-t_a$ | $p_y$ | $p_c$ | ρ | $u$ |
| F dummy labour productivity | | − | + | − | ++ | + | + |
| F Dummy payroll tax | + | | − | + | − | − − | − |
| F Dummy average retention rate | + | − | | − | + | + | − |
| F Dummy marginal retention rate | + | − | − | + | − | + | − |
| F Dummy consumer price | − | + | + | | − − | + | + |
| F Dummy producer price | + | − | − | − − | | − | + |
| F Dummy replacement rate | − | − | − | − | + | | − |
| F Dummy unemployment rate | + | − | + | ++ | − − | − | |
| R dummy payroll tax | + | − | − | − | − | − − | + |
| R dummy average retention rate | + | − | − | ++ | + | + | − |
| R dummy consumer price | − | ++ | + | − | − − | − | − |
| R dummy producer price | − | − | − | − | ++ | + | − |
| C Dummy labour productivity | + | + | − | − | ++ | + | − |
| C Dummy payroll tax | − | − − | − | + | − | − | − − |
| C Dummy consumer price | + | + | | + | | + | + |
| C Dummy producer price | + | − | | | ++ | + | + |

In case of the elasticity of the marginal income retention ratio $1-t_m$ the sample size limits the number of dummies in the regression. Therefore only the country dummies have been included.

From tables 6.1 and 6.2 and the detailed information in appendix D the following conclusions emerge:

### Labour productivity

The size of the general constant is some 80% of the sample mean and its standard error is small. Country dummies hardly have any impact. The inclusion of the marginal retention rate into the wage equation substantially increases the estimate of the elasticity. The size of the C dummy of labour productivity indicates that wage equations that estimate this elasticity yield on average lower values than if it is fixed a priori (in this case: at a value of 1).

### Payroll taxes

The results indicate a substantial difference between short and long term elasticities. Price variables matter especially. If the wage equation contains a price wedge, then this yields smaller elasticities (in absolute value). The C dummies of producer taxes and both price variables indicate that the unit of measurement of the wage variable has an impact on the results.

Equations formulated in terms of wage costs or real wages deflated by the producer price index result in higher elasticities (in absolute value). Deflation of wages using the consumer price index decreases the absolute size of the payroll tax elasticity.

**Average income retention rate**

The overall results are similar to those of the payroll tax elasticity: long term elasticities differ from short term. Wage equations estimated in levels only (without any dynamics) yield substantially higher (i.c. less negative) elasticities.

**Marginal income retention rate**

In this the sample consists of 18 observations only. The results indicate that the sample mean (or median) is possibly the best estimate of the elasticity.

**Consumer prices**

The use of single equation estimation methods produces higher elasticities. The inclusion of the output price has a significant negative impact, which is consistent with the results on the elasticity of $p_y$(see below). We may conclude that if one of the prices $p_y$ or $p_c$ is omitted from the wage equation, the elasticity of the remaining price is pushed upwards.

**Output prices**

Elasticities based on sector analysis are lower than their macro equivalents. The results also suggest the output price elasticity is substantially lower if the consumer price is included in the equation, either through a freely estimated parameter or a price wedge.

**Replacement ratio**

The sector dummy has a positive impact: the elasticity is higher than may be expected on basis of pure macroeconomic data. The hypothesis that the elasticity depends on the level of the unemployment rate (see section 5.2) finds some support: the estimated coefficients have the right (positive) sign, but estimated standard errors are relatively high. Just like in case of both tax elasticities of pay, entering tax variables through a wedge variable matters, but here the net impact is very modest.

**Unemployment rate**

The coefficient of the level of the replacement ratio doesn't have the expected sign: a higher replacement ratio increases the absolute value of the unemployment elasticity of pay. Therefore the level of unemployment has been omitted from the final regression. The fit is poor and only the Anglo Saxon dummy provides some explanatory power. The C dummy of the payroll tax indicates that equations that explain wage costs (in that case the C dummy equals 1) yield higher unemployment elasticities of pay in absolute value than nominal wage equations. From the discussion in appendix D it follows that if our observations had been obtained from simple regressions of the real wage on the unemployment ratio, unemployment elasticities would not systematically differ from what we observe now. This suggests that the size of the unemployment elasticities of pay from the meta analysis are comparable to those obtained from the wage curve literature.

### Overview of LAD outcomes

The results suggest that in estimating a specific elasticity of pay, variables from the set A: $\{q, 1+s, 1-t_a, 1-t_m, p_y, p_c, \rho, u\}$ may have an impact on the results. This mutual dependence is captured by the restriction dummies F, R and C. Table 6.3 summarizes this mutual interdependency of the estimated elasticities. Symbols refer to the type of dummy that embodies the relationship. To gain a clear view we have restricted the possible impact to dummies that show coefficients with p-values < 0.1.

**Table 6.3 Impact of restriction dummies on elasticities of pay**

| Elasticity of pay | Depends on inclusion of | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | $q$ | $1+s$ | $1-t_a$ | $1-t_m$ | $p_c$ | $p_y$ | ρ | $u$ |
| Labour productivity ($q$) | | | | | | | | |
| Payroll taxes ($1+s$) | | C | | | R | | | |
| Average retention rate ($1-t_a$) | | | | | | | | |
| Marginal retention rate ($1-t_m$) | | | | | | | | |
| Consumer price ($p_c$) | | | R | | | F | | F |
| Producer price ($p_y$) | FC | | | | FR | RC | | F |
| Replacement ratio (ρ) | | R | | | | | | |
| Unemployment rate ($u$) | | C | | | | | | |

An obvious result is that the output price elasticity of pay depends on the inclusion of the consumer price in the wage equation and vice versa. Both prices also have an important impact on tax elasticities. The producer taxes and output prices are main determinants of wage elasticities.

### System LS regressions

The regressions discussed so far are stand alone: variations in observed or computed elasticities within and across studies are linked to variations in moderator variables. Cross correlations between elasticities obtained from the same study have not been taken into account. Table 6.3 suggests that a system regression using elasticities of pay of consumer and producer prices, payroll and income taxes may be promising.

A number of important reasons hampers a meaningful comparison of the system regressions and the LAD estimates. First, systems regressions use only a fraction of the full data set. In the example above, the common sample of price and tax elasticities contains 53 observations on 4 elasticities, which is less than 40% of the full sample of 550 data points (see table 4.2). So the estimation method is more efficient, but the sample size is smaller. Second, the composition of the sample is different. The proportion of sectoral estimates in the common sample is higher, and this results in substantially lower sample means of output and consumer prices. Third, the relative shares of freely estimated, restricted and fixed elasticities change and this alters the sample means of some of the F, R, and C dummies, resulting in other values of benchmark elasticities. In addition, more difficulties arise due to differences in estimation method (LAD and LS) as well as between system and stand alone regressions. Therefore I do not report the regression results. In section 6.5, however, we will compare benchmark values computed from the system regression results with those from the single LAD and OLS regressions.

## 6.3 And the winner is...

#### Dummy variables

Do the results of the meta analysis generate more structural estimates of wage elasticities than sample means or median values? We apply equation (5.3) to answer this question and set dummy variables at their 'best' or 'required' values. Obviously these values are not unique. First, they depend on the kind of elasticities that we are interested in. Estimates by country group? Short run and long run elasticities? Macro or sectoral or just an average? Second, structural estimates are conditional on the specification of the preferred wage equation. By putting F, R and C dummies at their sample means we obtain an 'average' result. We use all information of estimated elasticities: free, restricted or fixed. Hence, the benchmark values illustrate the use of the regression results in case the wage equation is log linear.

The conclusions of section 6.2 on wage elasticities of prices suggests that it may not be correct to use full sample means for the restriction dummies of $p_c$ and $p_y$. Wage equations that just contain either of the two prices may yield biased elasticities for the included one. Therefore to compute benchmark elasticities for $\varepsilon_c$ and $\varepsilon_y$ we take the sample means of the F, R, and C dummies of $p_c$ and $p_y$ in the common sample of both prices. In other words: to compute benchmark values for $\varepsilon_c$ and $\varepsilon_y$ we use only results of wage equations that contain both price variables.

The results of our analysis do not permit the rejection of a specific wage equation in favour of another. So if we want to empirically quantify a specific wage equation, this implies a specific choice of the F, R and C restriction dummies. This may lead to different benchmark values than those reported below. I will illustrate this point in section 6.4. Dummies are set at values as given in table 6.4. Details can be found in appendix C.

**Table 6.4 Overview of Dummy variables**

| Dummy variable | Preferred value |
|---|---|
| Publication dummy | Sample mean |
| Time series dummy | 1 |
| Single equation estimation dummy | 0 |
| Bargaining dummy | 1 |
| Union density | 0 |
| First difference dummy | 0 (long run) or 1 (short run) |
| Dummy level estimation | 0 (short run) or sample mean (long run) |
| Sector dummy | 0 (macro) or 1 (aggregate) |
| Time dummy 1950-1969 | 0 |
| Time dummy 1990-2008 | 1 |
| F, R and C dummies of $p_c$ and $p_y$ , elasticities $\varepsilon_c, \varepsilon_y, \varepsilon_u$ | Sample mean in common sample of $p_c$ and $p_y$ |
| F, R and C dummies, all other cases | Sample mean in full sample |

**Benchmark values of wage elasticities**

Tables 6.5 - 6.8 report benchmark values of all elasticities by country group: long and short run values, macro and average. The definition of sector is not always clear-cut: it may be a specific industry, or region or even type of worker. Therefore just macro and average estimated are presented.

Wage elasticities of $1+s$, $1-t_a$ and $1-t_m$ can be converted to elasticities of tax rates $s$, $t_a$ and $t_m$ using the conversion formula's in appendix B (equation (B.19) - (B.21)). This requires country specific data on average producer and income tax rates ($s$ and $t_a$) and the marginal income tax rate $t_m$.

**Table 6.5 Elasticities of pay for The Netherlands**

| | Long term elasticity | | Short term elasticity | | Full sample statistics | |
|---|---|---|---|---|---|---|
| The Netherlands | Macro | Average | Macro | Average | Mean | Median |
| Labour productivity ($q$) | 0.830 | 0.832 | 0.812 | 0.814 | 0.875 | 1.000 |
| Payroll tax($1+s$) | – 0.785 | – 0.754 | – 0.392 | – 0.361 | – 0.659 | – 0.720 |
| Average income tax ($1-t_a$) | – 0.191 | – 0.226 | – 0.364 | – 0.399 | – 0.390 | – 0.368 |
| Marginal income tax ($1-t_m$) | 0.272 | 0.272 | 0.272 | 0.272 | 0.226 | 0.200 |
| Consumer price ($p_c$) | 0.536 | 0.584 | 0.577 | 0.625 | 0.725 | 0.790 |
| Producer price ($p_y$) | 0.393 | 0.342 | 0.334 | 0.282 | 0.657 | 0.774 |
| Replacement ratio (ρ) | 0.400 | 0.472 | 0.400 | 0.472 | 0.349 | 0.322 |
| Unemployment rate ($u$) | – 0.083 | – 0.080 | – 0.083 | – 0.080 | – 0.089 | – 0.064 |

**Table 6.6 Elasticities of pay for Anglo Saxon countries**

| Anglo Saxon countries | Long term elasticity Macro | Long term elasticity Average | Short term elasticity Macro | Short term elasticity Average | Sample statistics Mean | Sample statistics Median |
|---|---|---|---|---|---|---|
| Labour productivity ($q$) | 0.919 | 0.921 | 0.901 | 0.903 | 0.875 | 1.000 |
| Payroll tax(1+$s$) | – 0.726 | – 0.695 | – 0.333 | – 0.302 | – 0.659 | – 0.720 |
| Average income tax (1– $t_a$) | – 0.273 | – 0.308 | – 0.446 | – 0.481 | – 0.390 | – 0.368 |
| Marginal income tax (1– $t_m$) | 0.200 | 0.200 | 0.200 | 0.200 | 0.226 | 0.200 |
| Consumer price ($p_c$) | 0.532 | 0.580 | 0.573 | 0.621 | 0.725 | 0.790 |
| Producer price ($p_y$) | 0.450 | 0.399 | 0.391 | 0.339 | 0.657 | 0.774 |
| Replacement ratio (ρ) | 0.260 | 0.331 | 0.260 | 0.331 | 0.349 | 0.322 |
| Unemployment rate ($u$) | – 0.046 | – 0.043 | – 0.046 | – 0.043 | – 0.089 | – 0.064 |

**Table 6.7 Elasticities of pay for Nordic countries**

| | Long term elasticity Macro | Long term elasticity Average | Short term elasticity Macro | Short term elasticity Average | Sample statistics Mean | Sample statistics Median |
|---|---|---|---|---|---|---|
| Labour productivity ($q$) | 0.919 | 0.921 | 0.901 | 0.903 | 0.875 | 1.000 |
| Payroll tax(1+$s$) | – 0.756 | – 0.726 | – 0.363 | – 0.332 | – 0.659 | – 0.720 |
| Average income tax (1– $t_a$) | – 0.265 | – 0.300 | – 0.438 | – 0.472 | – 0.390 | – 0.368 |
| Marginal income tax (1– $t_m$) | 0.246 | 0.246 | 0.246 | 0.246 | 0.226 | 0.200 |
| Consumer price ($p_c$) | 0.472 | 0.520 | 0.513 | 0.561 | 0.725 | 0.790 |
| Producer price ($p_y$) | 0.549 | 0.497 | 0.490 | 0.438 | 0.657 | 0.774 |
| Replacement ratio (ρ) | 0.238 | 0.310 | 0.238 | 0.310 | 0.349 | 0.322 |
| Unemployment rate ($u$) | – 0.094 | – 0.090 | – 0.094 | – 0.090 | – 0.089 | – 0.064 |

**Table 6.8 Elasticities of pay for other countries**

| | Long term elasticity Macro | Long term elasticity Average | Short term elasticity Macro | Short term elasticity Average | Sample statistics Mean | Sample statistics Median |
|---|---|---|---|---|---|---|
| Labour productivity ($q$) | 0.919 | 0.921 | 0.901 | 0.903 | 0.875 | 1.000 |
| Payroll tax(1+$s$) | – 0.736 | – 0.705 | – 0.342 | – 0.312 | – 0.659 | – 0.720 |
| Average income tax (1– $t_a$) | – 0.269 | – 0.304 | – 0.442 | – 0.477 | – 0.390 | – 0.368 |
| Marginal income tax (1– $t_m$) | 0.011 | 0.011 | 0.011 | 0.011 | 0.226 | 0.200 |
| Consumer price ($p_c$) | 0.532 | 0.580 | 0.573 | 0.621 | 0.725 | 0.790 |
| Producer price ($p_y$) | 0.450 | 0.399 | 0.391 | 0.339 | 0.657 | 0.774 |
| Replacement ratio (ρ) | 0.297 | 0.368 | 0.297 | 0.368 | 0.349 | 0.322 |
| Unemployment rate ($u$) | – 0.082 | – 0.079 | – 0.082 | – 0.079 | – 0.089 | – 0.064 |

In all tables long run elasticities for labour productivity are smaller than one. Values for The Netherlands tend to be smallest, but country specific values are close to the sample mean.

Long and short term values of estimated tax elasticities in all countries substantially differ. In the short run, some 36% of an increase of producer payroll taxes is borne by employees; in the long run this amounts to75%. If real wages are sticky in the short run, producers adjust wage offers in later periods to shift the larger part of a past increase in payroll taxes to the employee. This is in line with Pissarides (1998) who concludes that the impact of a cut in payroll taxes affects both employment and wages. If the gross replacement ratio is constant, the impact is mainly on wages, but if the real income out of work is fixed, the main impact is on employment. So an increase in real wage flexibility over time shifts the impact of a payroll tax cut from employment to wages.

The opposite effect occurs in case of the average income retention ratio: the instantaneous impact (0.42) is about 70% higher than the long run impact (0.25 on average). If wages are fixed in the short run, an increase in income taxes is to a large extent borne by the employees. In future wage negotiations, employees (or unions) succeed in partially compensating the increase in income tax through higher wage claims.

Sectoral differences matter in case of prices and replacement ratio's. The impact on prices is likely connected with the competitive environment of a sector, that differs from the average situation. In case of the replacement ratio the fall back position for sectoral workers is to a large extent the alternative wage in other economic sectors, whereas the macro replacement ratio just refers to average unemployment and welfare benefits. Employers in a specific sector have to offer their employees higher wages if wages in the rest of the economy increase to prevent job quitting. So the elasticity may be higher than can be expected on basis of a pure macro benefit based replacement ratio.

The elasticities of the marginal retention ratio are clustered around the sample mean, but the average elasticity for the group of other countries is close to zero. Maybe this is due to the small sample size. In this case it may be better to use the sample median instead.

In all tables the sum of the two price elasticities is close to 1. If I took sample means of the complete sample, this would yield higher values of the price elasticities (the sum would be about 1.5). If either of the two prices is used to deflate wages (C dummy equals 1) or if the wage equation contains a price wedge (R dummies are equal to 1) different benchmark values may result.

Benchmark values of unemployment elasticities of pay are not very sensitive to the choice of the F, R and C dummies of $p_y$ and $p_c$. Using full sample dummies yields values that are 0.03 lower in absolute value than those reported above. On average, Anglo Saxon unemployment elasticities are about 50% lower than in case of other countries. A reason may be that the Anglo Saxon type of welfare state is less generous than those in other countries (Esping Andersen (1990)). The lower the real unemployment benefits, the stronger the incentive to look for a new job in case of unemployment and the lower the reservation wage. So an additional rise in unemployment may have a lesser impact on search intensity and wages than in more generous welfare states like those of Nordic countries and The Netherlands.

## 6.4 Wages and wedges

### Real wages and the price wedge

One of the factors that we have explored to link differences in the computed value of a particular wage elasticity is the specification of the corresponding reported wage equation: do restrictions on estimated coefficients matter? Restrictions may also implicitly be imposed in the data transformations of real wages, wage costs or net wages into gross wages. Therefore benchmark values of wage elasticities may depend on settings of the moderator variables, notably the F, R and C dummies. The previous section applied sample means for these restriction dummies. Is it possible to use the results of the meta analysis to obtain more specific benchmark elasticities, for example related to elasticities of the real wage?

We will discuss this by computing wage elasticities in a particular case. First, we impose that the wage elasticity of labour productivity equals 1. In the second step we also require that the elasticities of output and consumer prices add up to 1. As we will see, the resulting wage elasticities can be seen as benchmark values of real wage elasticities if the wage equation is linear in log's.

To compute benchmark values if $\varepsilon_q = 1$ requires that the C dummy of labour productivity equals 1 and the corresponding F and R dummies are zero. A value of 1 for the C dummy of productivity only indicates that the elasticity of the labour productivity is fixed, without specifying a particular value. In the meta sample the value always equals 1 in this case. Table 6.9 displays the results for benchmark values of the macro wage elasticities if $\varepsilon_q = 1$.

**Table 6.9 Benchmark values of macro wage elasticities if $\varepsilon_q = 1$, long and short term**

| | The Netherlands | | Anglo Saxon countries | | Nordic countries | | Other countries | |
|---|---|---|---|---|---|---|---|---|
| | Long | Short | Long | Short | Long | Short | Long | Short |
| Labour productivity ($q$) | 0.910 | 0.892 | 0.999 | 0.981 | 0.999 | 0.981 | 0.999 | 0.981 |
| Payroll tax($1+s$) | – 0.716 | – 0.323 | – 0.657 | – 0.264 | – 0.688 | – 0.294 | – 0.667 | – 0.274 |
| Average income tax ($1-t_a$) | – 0.329 | – 0.502 | – 0.411 | – 0.584 | – 0.403 | – 0.576 | – 0.407 | – 0.580 |
| Marginal income tax ($1-t_m$) | 0.272 | 0.272 | 0.200 | 0.200 | 0.246 | 0.246 | 0.011 | 0.011 |
| Consumer price ($p_c$) | 0.534 | 0.575 | 0.530 | 0.571 | 0.470 | 0.511 | 0.530 | 0.571 |
| Producer price ($p_y$) | 0.465 | 0.405 | 0.521 | 0.462 | 0.620 | 0.561 | 0.521 | 0.462 |
| Replacement ratio ($\rho$) | 0.525 | 0.525 | 0.384 | 0.384 | 0.362 | 0.362 | 0.421 | 0.421 |
| Unemployment rate ($u$) | – 0.090 | – 0.090 | – 0.052 | – 0.052 | – 0.100 | – 0.100 | – 0.089 | – 0.089 |

The first row shows that the restriction $\varepsilon_q = 1$ is not exactly reproduced in case of The Netherlands. As we will se below (table 6.10), the sample mean of the C dummy of labour productivity is just above 0.2; nevertheless the extrapolation towards a value of 1 is quite good. Second, other elasticities also change, but not that much. The sum of both price elasticities is for all countries in the range 1.0 - 1.1, which is slightly higher than reported in tables 6.5 - 6.8. It is still reasonable to impose our second restriction that this sum equals 1.

Suppose we have concluded from a theoretical model or a literature review that our preferred wage equation is log linear in its arguments. Then, if we impose the restrictions $\varepsilon_q = 1$ and $\varepsilon_c + \varepsilon_y = 1$, we may rewrite this equation as (see also appendix A, equation (A.5)):

$$\ln W = \ln q + \varepsilon_{1+s} \ln(1+s) + \varepsilon_{1-a} \ln(1-t_a) + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln p_c + (1-\varepsilon_c) \ln p_y + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u \tag{6.1}$$

or:

$$\ln \frac{W}{p_y} = \ln q + \varepsilon_{1+s} \ln(1+s) + \varepsilon_{1-a} \ln(1-t_a) + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln \Pi + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u \tag{6.2}$$

Note that, given that specification (6.1) is the true model elasticities in equation (6.2) refer to real wages. In this case the restrictions imply that the impact of prices on the real wage is fully captured by the price wedge. Note that from table 6.5 - 6.7 one may conclude that the sum of the benchmark values of both price elasticities is close to 1. This does not imply however, that equation (6.2) is necessarily true. The implicit assumption is that the output price is independent of the right hand side variables in equation (6.2) and on wages.

We mimic the restrictions by setting the R dummies of both prices to 1 which just indicates that estimated coefficients are restricted. In most cases this indeed refers to a price wedge; but some equations in the sample are even more restrictive as they impose equal elasticities for price and tax wedges. Table 6.10 summarizes all restrictions on moderator values that are implied by equation (6.2).

The sample mean of each dummy, given that elasticity *i* is observed differs from the mean value in case we observe elasticity *j*; see table B.1 in appendix B. The weighted sample mean is computed using the number of observations on each elasticity as weight. The table shows that restricted dummy values may substantially differ from the full sample means. Table 6.11 displays the resulting benchmark elasticities.

**Table 6.10 Dummy restrictions corresponding to equation (6.2)**

| Wage elasticity | Dummy type | Range of sample means | Weighted sample mean | Restricted value |
|---|---|---|---|---|
| Labour productivity | F | 0.3 - 0.7 | 0.430 | 0 |
| Labour productivity | R | 0.0 | 0.000 | 0 |
| Labour productivity | C | 0.1 - 0.3 | 0.228 | 1 |
| Consumer price | F | 0.3 - 0.6 | 0.473 | 0 |
| Consumer price | R | 0.0 - 0.7 | 0.244 | 1 |
| Consumer price | C | 0.0 - 0.1 | 0.037 | 0 |
| Output price | F | 0.3 - 0.7 | 0.543 | 0 |
| Output price | R | 0.1 - 0.7 | 0.230 | 1 |
| Output price | C | 0.0 - 0.4 | 0.111 | 0 |

Compared to earlier results, a number of things has changed:

(i) the elasticity of labour productivity is lower than before, but still close to 1 for most countries;

(ii) the sum of the wage elasticities of $p_c$ and $p_y$ is about 1.0, except for The Netherlands (= 0.95).

(iii) elasticities of the average income retention rate $(1- t_a)$ have increased in size, both in the long and the short run;

**Table 6.11 Benchmark values of macro real wage elasticities in equation (6.2), long and short term**

| | The Netherlands | | Anglo Saxon countries | | Nordic countries | | Other countries | |
|---|---|---|---|---|---|---|---|---|
| | Long | Short | Long | Short | Long | Short | Long | Short |
| Labour productivity ($q$) | 0.842 | 0.824 | 0.931 | 0.913 | 0.931 | 0.913 | 0.931 | 0.913 |
| Payroll tax$(1+s)$ | – 0.522 | – 0.129 | – 0.463 | – 0.070 | – 0.493 | – 0.100 | – 0.473 | – 0.079 |
| Average income tax $(1- t_a)$ | – 0.419 | – 0.592 | – 0.501 | – 0.674 | – 0.493 | – 0.666 | – 0.497 | – 0.670 |
| Marginal income tax $(1- t_m)$ | 0.272 | 0.272 | 0.200 | 0.200 | 0.246 | 0.246 | 0.011 | 0.011 |
| Consumer price ($p_c$) | 0.398 | 0.439 | 0.394 | 0.435 | 0.334 | 0.375 | 0.394 | 0.435 |
| Producer price ($p_y$) | 0.554 | 0.495 | 0.611 | 0.552 | 0.709 | 0.650 | 0.611 | 0.552 |
| Replacement ratio ($\rho$) | 0.115 | 0.115 | – 0.025 | – 0.025 | – 0.047 | – 0.047 | 0.012 | 0.012 |
| Unemployment rate ($u$) | – 0.133 | – 0.133 | – 0.095 | – 0.095 | – 0.143 | – 0.143 | – 0.131 | – 0.131 |

(iv) payroll tax elasticities are substantially smaller in absolute value; – 0.38 in the long run and slightly positive in the short run.

(v) unemployment elasticities of pay almost double in size;

(vi) the elasticity of the replacement rate falls down to almost zero or becomes even negative.

The earlier outcomes of tables 6.7 - 6.9 virtually obey the restrictions imposed; why do the results of table 6.11 differ so much? The first reason may be that output prices and wages are mutually dependent: in this case real wage elasticities differ from nominal wage elasticities. Second, from table 6.10 it follows that the number of restrictions on dummies (9) is relatively high; in this case our extrapolations may lose accuracy. Finally our sample is not balanced: the number of observations differs across elasticities and some wage equations are more 'complete' than others; see figure 4.1. In other words: the thickness of the ice is not uniform: if we impose too many restrictions we move away from the safe place and get in thin ice. This may explain the unexpected values for the replacement rate elasticity: the number replacement elasticities obtained from a real wage equation that contains a price wedge is only 2.

Some preliminary conclusions may be drawn:

(i) elasticities of nominal and real wages generally differ, notably with respect to taxes, net replacement rates and the unemployment rate;

(ii) price elasticities based on nominal and real wage equations are roughly the same. If the sum of both price elasticities of the nominal wage is close to one, it may not be bad to assume that this will also hold in case of price elasticities of the real wage;

(iii) the elasticity of producer taxes is highly sensitive to the deflation of wages. A possible explanation is that output prices react on changes in producer taxes. In this case we may write the total payroll tax elasticity $E_{1+s}$ as:

$$\frac{1+s}{W}\frac{dW}{d(1+s)} = \left(\frac{p_y}{W}\frac{\partial W}{\partial p_y}\right)\left(\frac{1+s}{p_y}\frac{\partial p_y}{\partial(1+s)}\right) + \frac{1+s}{W}\frac{\partial W}{\partial(1+s)} \tag{6.3}$$

or:

$$E_{1+s} = \varepsilon_y \omega_{1+s} + \varepsilon_{1+s} \tag{6.4}$$

The total payroll tax elasticity of wages $E_{1+s}$ equals the partial elasticity $\varepsilon_{1+s}$ plus the product of the output price elasticity of wages $\varepsilon_y$ and the payroll tax elasticity of the output price $\omega_{1+s}$. If we assume that the latter is positive, it follows that $| E_{1+s} | < | \varepsilon_{1+s} |$.

(iv) The unemployment elasticity of pay is more than doubled. From table D.7 in appendix D it follows that the estimated coefficients of the R dummies of $p_c$ and $p_y$ are substantial, but highly insignificant. Inspection of the sample shows that only 19 out of 223 observations of the unemployment elasticity of pay refer to wage equations that contain a price wedge. Therefore not much value should be attached to the reported unemployment elasticity in table 6.11.

**The tax wedge and Dalton's law**

A number of authors (Layard *et al* (1991), Bean *et al* (1986)) argue that the key variable that explains the distortion of labour taxes on wage formation is the tax wedge. This is in line with the "most basic theorem of public finance" (Blinder(1988)) that if a tax is levied in a perfect competitive market (with fixed labour supply) it does not matter who pays the tax on labour: it is the gap between payroll and employee taxes that matters. This result is known as Dalton's law (Muysken *et al* (1999). The law implies that a neutral shift from producer payroll taxes to income tax has no impact on employment and wages.

This neutral shift can be defined in two ways (Goerke (2000)). When the shift leaves total tax revenue unchanged, the law does not hold if the shift affects the structure of the tax system, e.g. when the tax bases are unequal due to income tax allowances (Koskela and Schöb (1999)). An alternative tax shift leaves the tax wedge unchanged. Goerke (2000) uses this definition to apply Dalton's law to social security taxes. He argues that if labour supply depends on the alternative income (e.g. an unemployment benefit), the wedge neutral tax shift will lower the net replacement ratio if unemployment benefits are also subject to social security taxes. Do the meta results add something to this discussion?

From section 6.3 it follows that an increase in payroll taxes is partly shifted to employees: the long run wage elasticity exceeds its short run value. A rise in the average retention ratio however dampens out: the long run elasticity is smaller in size than the short run. These results confirm the common view that shifting the tax burden takes time, and so Dalton's law may hold in the long run only.

Now the results of table 6.5 - table 6.7 all indicate that the sum of the elasticities of payroll tax and the average income retention rate is virtually – 1:

$$\varepsilon_{1+s} + \varepsilon_{1-a} = -1 \tag{6.5}$$

Given the restriction in (6.5), we may rewrite a log linear wage equation like (3.5) as:

$$\ln W = \varepsilon_q \ln q + \varepsilon_{1+s} \ln \Lambda - \ln(1-t_a) + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln p_c + \varepsilon_y \ln p_y + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u \tag{6.6}$$

where the tax wedge $\Lambda$ is defined in equation (4.1). We may rewrite (6.5) in terms of gross wage costs or net wages:

$$\begin{aligned} \ln W(1+s) &= \varepsilon_q \ln q + (1+\varepsilon_{1+s}) \ln \Lambda + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln p_c + \varepsilon_y \ln p_y + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u \\ \ln W(1-t_a) &= \varepsilon_q \ln q + \varepsilon_{1+s} \ln \Lambda + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln p_c + \varepsilon_y \ln p_y + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u \end{aligned} \tag{6.7}$$

A wedge neutral shift in taxes may alter gross wage costs and net wages through a change in the marginal retention ratio and the net replacement ratio. Let's examine the numerical consequences and compute benchmark values given the restriction (6.5). This can be done by setting the R dummies for (1+*s*) and (1− $t_a$) to 1 (and F and C dummies to 0). Table 6.12 displays the results.

**Table 6.12 Benchmark values of macro real wage elasticities in equation (6.7), long and short term**

| | The Netherlands | | Anglo Saxon countries | | Nordic countries | | Other countries | |
|---|---|---|---|---|---|---|---|---|
| | Long | Short | Long | Short | Long | Short | Long | Short |
| Labour productivity (*q*) | 0.894 | 0.876 | 0.983 | 0.965 | 0.983 | 0.965 | 0.983 | 0.965 |
| Payroll tax(1+*s*) | – 0.687 | – 0.294 | – 0.629 | – 0.236 | – 0.659 | – 0.266 | – 0.638 | – 0.245 |
| Average income tax (1– $t_a$) | – 0.238 | – 0.411 | – 0.321 | – 0.493 | – 0.312 | – 0.485 | – 0.316 | – 0.489 |
| Marginal income tax (1– $t_m$) | 0.272 | 0.272 | 0.200 | 0.200 | 0.246 | 0.246 | 0.011 | 0.011 |
| Consumer price ($p_c$) | 0.607 | 0.648 | 0.603 | 0.644 | 0.543 | 0.584 | 0.603 | 0.644 |
| Producer price ($p_y$) | 0.388 | 0.329 | 0.445 | 0.386 | 0.544 | 0.484 | 0.445 | 0.386 |
| Replacement ratio (ρ) | 0.198 | 0.198 | 0.057 | 0.057 | 0.035 | 0.035 | 0.094 | 0.094 |
| Unemployment rate (*u*) | – 0.095 | – 0.095 | – 0.057 | – 0.057 | – 0.105 | – 0.105 | – 0.094 | – 0.094 |

The sum of $\varepsilon_{1+s}$ and $\varepsilon_{1-a}$ is indeed close to 1 in the long run. The elasticity of the replacement ratio declines but is still above 0.2 in most countries. Elasticities of labour productivity and prices are somewhat higher, and the unemployment elasticity is stable.

Even a wedge neutral shift from payroll tax to income tax that does not change the average tax burden on the average wage, increases the tax burden on unemployment and welfare benefits: the net replacement ratio declines. This results from the reduction in the tax credit or tax exemption that is imposed to induce the shift. This can be avoided of course, but in that case the marginal tax rate will increase.

From the table it follows that both the elasticity of the marginal income retention rate and the elasticity of the replacement rate differ from zero. So wages will mainly be affected through changes in the tax structure and the replacement ratio. There may also be indirect effects though changes in (un)employment and output prices.

## 6.5 System LS regressions

As outlined in section 6.2, possible correlations between elasticities obtained from the same wage equation have not been taken into account so far. Table 6.3 suggests that wage elasticities of price and tax variables may be mutually dependent and the same possibly holds for elasticities of prices and unemployment. To investigate this I relaxed the assumption of independence of the error terms across meta regressions (see equation (5.3)). For each observation in the common sample of $\{\varepsilon_{1+s}, \varepsilon_{1-a}, \varepsilon_c, \varepsilon_y\}$ and $\{\varepsilon_u, \varepsilon_c, \varepsilon_y\}$ I now assume that the disturbance terms of the concerning meta regressions have a common covariance matrix that is the same for each observation. Recall that this exactly implies that elasticities obtained from the same study are correlated, and that inter study correlations are neglected. The first subsystem contains 63 common observations, the second system includes 48. From the regression results I computed benchmark elasticities using the dummy settings from table 6.4. Tables 6.13 - 6.16 summarize the results. For comparison elasticities from LAD and OLS regressions have been included as well.

**Table 6.13 Benchmark values of macro wage elasticities, long and short term**

| The Netherlands | LAD | | OLS | | system 1 | | system 2 | |
|---|---|---|---|---|---|---|---|---|
| | Long | Short | Long | Short | Long | Short | Long | Short |
| Labour productivity ($q$) | 0,830 | 0,812 | 0,811 | 0,712 | | | | |
| Payroll tax(1+$s$) | – 0,777 | – 0,384 | – 0,753 | – 0,273 | – 0,743 | – 0,326 | | |
| Average income tax (1– $t_a$) | – 0,185 | – 0,357 | – 0,280 | – 0,452 | – 0,235 | – 0,522 | | |
| Marginal income tax (1– $t_m$) | 0,272 | 0,272 | 0,272 | 0,272 | | | | |
| Consumer price ($p_c$) | 0,414 | 0,455 | 0,422 | 0,434 | 0,451 | 0,485 | 0,554 | 0,554 |
| Producer price ($p_y$) | 0,415 | 0,356 | 0,505 | 0,328 | 0,380 | 0,364 | 0,357 | 0,357 |
| Replacement ratio (ρ) | 0,250 | 0,250 | 0,346 | 0,346 | | | | |
| Unemployment rate ($u$) | – 0,087 | – 0,087 | – 0,130 | – 0,130 | | | – 0,099 | – 0,099 |

**Table 6.14 Benchmark values of macro wage elasticities, long and short term**

| Anglo Saxon countries | LAD | | OLS | | system 1 | | system 2 | |
|---|---|---|---|---|---|---|---|---|
| | Long | Short | Long | Short | Long | Short | Long | Short |
| Labour productivity ($q$) | 0.919 | 0.901 | 0.911 | 0.812 | | | | |
| Payroll tax(1+$s$) | – 0.719 | – 0.326 | – 0.719 | – 0.239 | – 0.648 | – 0.231 | | |
| Average income tax (1– $t_a$) | – 0.267 | – 0.440 | – 0.380 | – 0.552 | – 0.400 | – 0.688 | | |
| Marginal income tax (1– $t_m$) | 0.200 | 0.200 | 0.278 | 0.278 | | | | |
| Consumer price ($p_c$) | 0.410 | 0.451 | 0.354 | 0.366 | 0.426 | 0.460 | 0.571 | 0.571 |
| Producer price ($p_y$) | 0.472 | 0.413 | 0.578 | 0.401 | 0.536 | 0.520 | 0.470 | 0.470 |
| Replacement ratio (ρ) | 0.109 | 0.109 | 0.040 | 0.040 | | | | |
| Unemployment rate ($u$) | – 0.049 | – 0.049 | – 0.087 | – 0.087 | | | – 0.032 | – 0.032 |

**Table 6.15 Benchmark values of macro wage elasticities, long and short term**

| Nordic Countries | LAD | | OLS | | system 1 | | system 2 | |
|---|---|---|---|---|---|---|---|---|
| | Long | Short | Long | Short | Long | Short | Long | Short |
| Labour productivity ($q$) | 0.919 | 0.901 | 0.952 | 0.853 | | | | |
| Payroll tax(1+$s$) | – 0.749 | – 0.356 | – 0.830 | – 0.350 | – 0.764 | – 0.347 | | |
| Average income tax (1– $t_a$) | – 0.258 | – 0.431 | – 0.346 | – 0.518 | – 0.353 | – 0.640 | | |
| Marginal income tax (1– $t_m$) | 0.246 | 0.246 | 0.273 | 0.273 | | | | |
| Consumer price ($p_c$) | 0.350 | 0.391 | 0.442 | 0.454 | 0.677 | 0.710 | 0.876 | 0.876 |
| Producer price ($p_y$) | 0.570 | 0.511 | 0.579 | 0.402 | 0.274 | 0.258 | 0.161 | 0.161 |
| Replacement ratio (ρ) | 0.087 | 0.087 | 0.081 | 0.081 | | | | |
| Unemployment rate ($u$) | – 0.097 | – 0.097 | – 0.126 | – 0.126 | | | – 0.103 | – 0.103 |

**Table 6.16 Benchmark values of macro wage elasticities, long and short term**

| Other Countries | LAD | | OLS | | system 1 | | system 2 | |
|---|---|---|---|---|---|---|---|---|
| | Long | Short | Long | Short | Long | Short | Long | Short |
| Labour productivity ($q$) | 0.919 | 0.901 | 0.902 | 0.803 | | | | |
| Payroll tax(1+$s$) | – 0.728 | – 0.335 | – 0.685 | – 0.204 | – 0.541 | – 0.124 | | |
| Average income tax (1– $t_a$) | – 0.263 | – 0.436 | – 0.354 | – 0.526 | – 0.392 | – 0.680 | | |
| Marginal income tax (1– $t_m$) | 0.011 | 0.011 | 0.149 | 0.149 | | | | |
| Consumer price ($p_c$) | 0.410 | 0.451 | 0.490 | 0.502 | 0.575 | 0.608 | 0.731 | 0.731 |
| Producer price ($p_y$) | 0.472 | 0.413 | 0.539 | 0.362 | 0.373 | 0.357 | 0.307 | 0.307 |
| Replacement ratio (ρ) | 0.146 | 0.146 | 0.176 | 0.176 | | | | |
| Unemployment rate ($u$) | – 0.086 | – 0.086 | – 0.125 | – 0.125 | | | – 0.097 | – 0.097 |

Tax elasticities are not very sensitive to the estimation method: the difference between short and long term values emerges from all regressions. The sum of the long term elasticities of 1+$s$ and 1– $t_a$ is still close to 1. Short term elasticities of the average retention rate tend to be higher in least squares regressions, however.

Although the sum of the wage elasticities of $p_c$ and $p_y$ is fairly stable, in the system regressions the elasticity of the consumer price tends to increase, leading to low values of $\varepsilon_y$, especially in case of the Nordic countries. Benchmark elasticities of the unemployment elasticity of pay obtained from the system regressions confirm the earlier conclusions that the size of the elasticity in Anglo Saxon countries is roughly half that of other country groups.

# 7 Conclusions

## 7.1 General findings

A meta analysis is a quantitative instrument to support a literature survey. Did it give any support? The answer is clearly yes. One of the merits of this meta analysis is that it shows that best values may differ from sample statistics like the mean and median. The reason is of course that variation is not just white noise, it is in part systematic. One of the conclusions is that part of the variation is due to different specifications of the reported wage equations. Moderator variables should not just include institutional, time or regional dummies, but also variables that account for different specifications. Moreover, it matters how coefficients have been estimated also holds in this case. Fixing a price variable for example, may result in a different value for the unemployment elasticity of pay.

As to the latter, our findings confirm those found in the literature on wage curves. Sample means, median values and elasticities obtained from this analysis yield values that are close to the findings of Blanchflower and Oswald (1994), Nijkamp and Poot (2005) and Clar *et al* (2007).

In a number of cases we also found differences between short and long term elasticities. The impact of changes in the average retention rate declines in the long run, while the impact of producer payroll taxes and productivity changes gain strength in the long term. These findings are confirmed using Least Squares regressions of a cluster of elasticities.

Finally, the ‘best’ values computed in section 6 may provide a guideline in calibrating empirical models. Alternative computations using OLS or LS system regressions confirm the main conclusions. The range of values gives some indication of the reliability of the results.

## 7.2 A dozen do’s and don’t’s

A meta analysis has a spill-over effect: you get aware of things you already knew, but which tend to slip away to a mouldy part of your memory. Here are some:

1 Limit your research: read what you need, not anything that might be of interest.

2 To get an idea of what you need, look for books, overviews an meta analyses of others.

3 Restrict your time: every extra day may yield an unseen paper with new information, but, as Shakespeare said: enough is enough.

4 Believe a lot, but not everything. Beware of outliers that will make an alien dummy highly significant.

5 Beware of the t-statistics syndrome: they do not tell you whether your specification is correct or not. An important variable may show little variation in your sample, but that does not imply that related policy reforms will have no impact.

6 A meta analysis may go beyond your field of expertise. Call in experts, and test your findings.

7 There are certainly more possible specifications of your regressions than bus stops. Therefore it’s better to carefully plan your route, than to stop everywhere.

8 In selecting relevant literature, don’t rely on a single scope, like scanning articles ‘wage equations’. Screening on titles may be misleading. Many useful wage equations have been estimated to gain insight in unemployment, inflation, tax reforms.

9 About 90% of your time will be spent on reading and ordering (Stanley(2001)). Therefore, organize your database well. Record anything and every step you made.

10 It proved to be very useful not only to setup a database with all sort of descriptive statistics, but also a comprehensive separate review that highlights the main characteristics of the papers.

11 If you have to transform your relevant variable, don’t forget that many spectacular insights tend to be based on computation errors.

12 If your material is inconclusive, it is!

# Appendix A Wage definitions and the wage equation

This appendix deals with the derivation of wage elasticities from generally specified wage equations (A.1), the transformation of wage elasticities to elasticities of the gross yearly wage per employee (A.2) and the relation between elasticities obtained from general log linear wage equations and log linear equations that contain tax or price wedges (A.3). Finally, it illustrates why I have omitted elasticities linked to an import price wedge rather than the ratio of consumer and producer prices (A.4) and how to derive elasticities if one of the explanatory variables is not expressed in logarithmic form (A.5).

## A.1 Long term elasticities in a general wage equation

If we are interested in *N* wage elasticities $\varepsilon_i, i = 1, \ldots, N$ , how can they be obtained from empirical equations? First, we divide all possible regressors of published wage equations into two subsets. The first, with general element $X_i$, contains all variables linked to the desired elasticities. All other possible explanatory variables are denoted as $Z_j$ ( j=1,..., M). Then a general formulation of a dynamic wage equation is:

$$\alpha(L)F(W) = G\left(\sum_{i=1}^{N} \beta_i(L)H_i(X_i), \sum_{j=1}^{M} \gamma_j(L)K_j(Z_j)\right) \tag{A.1}$$

here $F(.)$, $G$, $H_i(.)$ and $K_j(.)$ are general functional forms and $\alpha(L)$, $\beta_i(L)$, and $\gamma_j(L)$ are lag polynomials. $L$ is the lag operator, defined by

$$\begin{aligned} &L(V_t) = V_{t-1} \\ &\lambda(L)V_t = \lambda_0 V_t + \lambda_1 V_{t-1} + \ldots + \lambda_i V_{t-i} + \ldots \end{aligned} \tag{A.2}$$

for any time-dependent variable *V*.

Equation (A.1) is very general and so we make some suitable assumptions that directly relate coefficients to long run elasticities. First we assume that the function $G(.)$ is additively separable in its arguments. Second, we adopt a specification that directly links elasticities to parameter values, i.e. a log-linear specification. Finally, we state that the equation can be transformed with gross wages *W* as the dependent variable. These restrictions reduce equation (A.1) to:

$$\alpha(L)\ln W = \sum_{i=1}^{N} \beta_i(L)\ln X_i + \sum_{j=1}^{M} \gamma_j(L)\ln Z_j \tag{A.3}$$

This is just a convenient way to summarize the empirical results; it does not necessarily imply that I have only used outcomes of studies that adopt the formulation of equation (A.3). From section 4 it follows that there are many ways to specify the left hand variable of the wage equation ('wage'). If the specification is log-linear then it is rather straightforward to rewrite it in terms of one suitable definition, like 'gross wages' or 'wage costs' (see below).

If we normalize the polynomial $\alpha(L)$ by putting $\alpha_0$ to 1, then the long run elasticity with respect to variable $X_i$ can be obtained as:

$$\varepsilon_i = \frac{\sum_{k=1} \beta_{ki}}{1 - \sum_{j=1} \alpha_j} \tag{A.4}$$

where $\beta_{ki}$ is the $k$-th coefficient of the lag polynomial $\beta_i(L)$, i.e. the coefficient of $X_i(t-k)$. Once the elasticities have been computed, we can relate them to a log linear version of a long run wage equation:

$$\ln W = \varepsilon_q \ln q + \varepsilon_{1+s} \ln(1+s) + \varepsilon_{1-a} \ln(1-t_a) + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln p_c + \varepsilon_y \ln p_y + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u \tag{A.5}$$

In equation (A.5) the parameters $\varepsilon$ indicate long run elasticities of pay; explanatory variables $Z_j$ (j=1,...,M) (including a general constant) have been omitted for simplicity. This formulation can easily be used to transform elasticities relating to all types of wage definitions in table 3.1 into elasticities of the yearly gross wage per employee W.

## A.2 Equations containing wedge variables

In empirical studies, even if the equation is log-linear, the analytical form of the right hand side variables may differ from the specification in equation (B.5). One may for example include the tax wedge $\Lambda$, the price wedge $\Pi$ and the degree of tax progression $\tau_p$ (Jacobson (1994)) into the wage equation:

$$\ln W = \beta_1 \ln \Lambda + \beta_2 \ln (1-\tau_p) + \beta_3 \ln (1-\tau_a) + \beta_4 \ln (1-\tau_m) +$$

$$\beta_5 \ln \Pi + \beta_6 \ln p_c + \beta_7 \ln p_y + \beta_8 \ln \rho + \beta_9 \ln u$$

$$-1 \le \beta_1 \le 0, \quad \beta_2 \ge 0 \tag{A.6}$$

$$\Lambda = \frac{1+s}{1-\tau_a}, \quad 1-\tau_p = \frac{1-\tau_m}{1-\tau_a}, \quad \Pi = \frac{p_c}{p_y}$$

Equation (A.6) can easily be transformed into the format of (A.5) using the definitions of the wedge variables $\Lambda$ and $\Pi$ and the degree of tax progression. In equation (A.6) one would possibly expect the coefficients of the separate tax variables ( $\beta_3$ and $\beta_4$ ), and the price variables ( $\beta_6$ and $\beta_7$ ) to be zero as in that case (A.6) can still be rewritten in the form of equation (A.5). The opposite does however not hold: if $\beta_3$ , $\beta_4$ , $\beta_6$ and $\beta_7$ are set to zero equation (A.6) is more restrictive than (A.5).

## A.3 Transformations to elasticities of the gross yearly wage

#### From hourly to yearly wages

Suppose that extra remunerations are proportional to hourly wages. If the total number of hours worked per employee per year $h_y$ is independent of the hourly wage, one may write yearly gross wage per employee W in terms of the wage rate $W^h$ :

$$W = W^h (1+v) h_y \tag{A.7}$$

with $v$ the additional payments per hour worked, expressed as share of the hourly wage rate. Now denote the elasticity of the hourly wage rate $W^h$ with respect to production per hour $q^h$ by $\varepsilon_q^h$ :

$$\varepsilon_q^h = \frac{\partial \log W^h}{\partial \log q^h} \tag{A.8}$$

using (A.8) we may write equation (A.5) as:

$$\ln W^h \equiv \ln \frac{W}{h_y(1+v)} = \varepsilon_q^h \ln q^h + \ldots \Rightarrow$$

$$\ln W = \varepsilon_q^h \ln q^h + \ln(1+v) - \varepsilon_q \ln h_y + \ldots = \tag{A.9}$$

$$\varepsilon_q \ln q + \ln(1+v) + (1-\varepsilon_q) \ln h_y + \ldots$$

From equation (A.9) one may conclude that the labour productivity elasticities of pay based upon hourly $\varepsilon_q^h$ and yearly wages $\varepsilon_q$ are similar, given that extra remunerations are proportional to the hourly wage rate and that changes in total number of hours worked are taken into account in the yearly wage equation. Quarterly or monthly wages can be treated similarly.

**Wage costs and real wages**

The transformation of wage costs and real wage definitions to nominal wages is more straightforward. Using the appropriate definitions it is easy to see which elasticities are affected by a transformation and by how much. Denoting gross wage costs by $W^p$ they can be written as:

$$W^p = W(1+s) \tag{A.10}$$

$W^p$ is also known as the producer wage, $s$ is the payroll tax rate paid by the producer. Equation (A.10) implies that the payroll tax elasticity of wage costs equals $1+\varepsilon_s$ : positive and smaller than 1. Other elasticities are unaffected by the transformation.

From now on by assumption 'real' refers to the use of the output price $p_y$ as deflator. So real wages per employee and real wage costs are written as:

$$\frac{W}{p_y} \; and \; \frac{W(1+s)}{p_y} \equiv \frac{W^p}{p_y} \tag{A.11}$$

The net wage per employee $W^N$ equals gross wage times the average retention ratio $1-t_a$ , with $t_a$ the average income tax rate:

$$W^N = W(1-t_a) \equiv \frac{W^P(1-t_a)}{1+s} \tag{A.12}$$

So the net wage elasticity of $1-t_a$ equals the gross wage elasticity plus 1. The real consumer wage is commonly defined as the after tax wage of the employee ( $W^C$ ) deflated by the consumption price index $p_c$ :

$$\frac{W^C}{p_c} \equiv \frac{W(1-t_a)}{p_y}\frac{p_y}{p_c} = \frac{W(1-t_a)}{p_y}\left(\frac{p_c}{p_y}\right)^{-1} \tag{A.13}$$

and hence equals the real net wage times the inverse of the price wedge.

## A.4 Equivalence between equations (A.5) and (A.6)

Recall the specification of the long run wage equation (A.5):

$$\ln W = \varepsilon_q \ln q + \varepsilon_{1+s} \ln(1+s) + \varepsilon_{1-a} \ln(1-t_a) + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln p_c + \\ \varepsilon_y \ln p_y + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u \tag{A.14}$$

An alternative formulation includes the tax wedge Λ, the price wedge Π and the degree of tax progression $\tau_p$:

$$\ln W = \beta_1 \ln \Lambda + \beta_2 \ln(1-\tau_p) + \beta_3 \ln(1-\tau_a) + \beta_4 \ln(1-\tau_m) + \\ \beta_5 \ln \Pi + \beta_6 \ln p_c + \beta_7 \ln p_y + \beta_8 \ln \rho + \beta_9 \ln u \\ -1 \le \beta_1 \le 0, \quad \beta_2 \ge 0 \\ \Lambda = \frac{1+s}{1-\tau_a}, \quad 1-\tau_p = \frac{1-\tau_m}{1-\tau_a}, \quad \Pi = \frac{p_c}{p_y} \tag{A.15}$$

Let us explore the relation between elasticities ε from (A.14) and β from (A.15). First, we concentrate on differences due to the use of the tax wedge Λ and the degree of tax progression $\tau_p$ .There are 7 possible cases.

(i) $\varepsilon_{1+s} + \varepsilon_{1-a} + \varepsilon_{1-m} > 0$

One may rewrite (A.15) as:

$$\ln W = \varepsilon_{1+s} \ln \Lambda - \varepsilon_{1-a} \ln(1-\tau_p) + (\varepsilon_{1+s} + \varepsilon_{1-a} + \varepsilon_{1-m}) \ln(1-\tau_m) + \ldots \tag{A.16}$$

(ii) $\varepsilon_{1+s} + \varepsilon_{1-a} + \varepsilon_{1-m} < 0$

Now we obtain:

$$\ln W = \varepsilon_{1+s} \ln \Lambda + \varepsilon_{1-m} \ln (1-\tau_p) + (\varepsilon_{1+s} + \varepsilon_{1-a} + \varepsilon_{1-m}) \ln (1-\tau_a) + \ldots \tag{A.17}$$

(iii) $\varepsilon_{1+s} + \varepsilon_{1-a} + \varepsilon_{1-m} = 0$

In this case (A.15) can be written as:

$$\ln W = \varepsilon_{1+s} \ln \Lambda + \varepsilon_{1-m} \ln (1-\tau_p) + \ldots \tag{A.18}$$

(iv) $\varepsilon_{1+s} = 0, \varepsilon_{1-a} + \varepsilon_{1-m} > 0$

This is a special case of (i). Now (A.15) equals:

$$\ln W = -\varepsilon_{1-a} \ln (1-\tau_p) + (\varepsilon_{1-a} + \varepsilon_{1-m}) \ln (1-\tau_m) + \ldots \tag{A.19}$$

(vi) $\varepsilon_{1+s} = 0, \varepsilon_{1-a} + \varepsilon_{1-m} < 0$

This follows from case (ii), (A.15) becomes:

$$\ln W = \varepsilon_{1-m} \ln (1-\tau_p) + (\varepsilon_{1-a} + \varepsilon_{1-m}) \ln (1-\tau_a) + \ldots \tag{A.20}$$

(vii) $\varepsilon_{1-m} = 0$

In this case (A.16) or (A.17) applies (with $\varepsilon_{1-m} = 0$) depending on the sign of $\varepsilon_{1+s} + \varepsilon_{1-a}$. Equations (A.16) to (A.20) relate values of $\varepsilon_{1+s}, \varepsilon_{1-a}$ and $\varepsilon_{1-m}$ to estimates of $\beta_1, \ldots \beta_4$.

If the price wedge Π enters the specification we have only three possibilities

(i) $\varepsilon_c < \varepsilon_y$

and (A.15) becomes

$$\log W = \ldots + \varepsilon_c \ln \Pi + (\varepsilon_y + \varepsilon_c) \ln p_y + \ldots \tag{A.21}$$

(ii) $\varepsilon_c > \varepsilon_y$

and we obtain

$$\log W = \ldots - \varepsilon_y \ln \Pi + (\varepsilon_c - \varepsilon_y) \ln p_c + \ldots \tag{A.22}$$

(iii) $\varepsilon_c = \varepsilon_y$

In this case we rewrite (A.15) as:

$$\ln W = \ldots + \varepsilon_c \ln \Pi + \ldots \tag{A.23}$$

In addition, it holds that $\beta_8 = \varepsilon_\rho$ and $\beta_9 = \varepsilon_u$.

A special case applies if $\varepsilon_c + \varepsilon_y = 1$. No matter of the size of both elasticities (as long as both are nonnegative) we may write the wage equation as:

$$\ln \frac{W}{p_y} = \ldots + \varepsilon_c \ln \Pi + \ldots \tag{A.24}$$

In some studies the product of the tax and the price wedge is used (e.g. Calmfors and Forslund (1991), Carruth and Schnabel(1993), Holmlund and Zetterberg(1991)). This just imposes an additional restriction on estimated coefficients.

The definition of the tax wedge Λ has been used to compute separate elasticities for the payroll tax and the average retention rate from 46 reported tax wedge elasticities. Similarly, 26 reported price wedge elasticities have been decomposed into a consumer and a producer price component.

## A.5 Conversion of tax elasticities

Wage elasticities of tax variables 1+$s$, 1-$t_a$ and 1-$t_m$ ($\varepsilon_{1+s}, \varepsilon_{1-a}, \varepsilon_{1-m}$) can easily be rewritten in terms of the corresponding elasticities of the tax rates $s$, $t_a$ and $t_m$ ($\varepsilon_s, \varepsilon_a, \varepsilon_m$):

$$\varepsilon_s = \frac{s}{W}\frac{\partial W}{\partial s} = \frac{1+s}{W}\frac{\partial W}{\partial 1+s}\frac{s}{1+s} = \frac{s}{1+s}\varepsilon_{1+s} \tag{A.25}$$

$$\varepsilon_a = \frac{t_a}{W}\frac{\partial W}{\partial t_a} = \frac{1-t_a}{W}\left(-\frac{\partial W}{\partial(1-t_a)}\right)\frac{t_a}{1-t_a} = -\frac{t_a}{1-t_a}\varepsilon_{1-a} \tag{A.26}$$

$$\varepsilon_m = -\frac{t_m}{1-t_m}\varepsilon_{1-m} \tag{A.27}$$

#### The import price wedge

In a number of papers the consumer price does not enter the wage equation; its influence is captured by the import price $p_m$ and the tax rate on consumption (Padoa Schioppa (1990), Carruth and Oswald(1987)). An alternative way to add import price $p_m$ and the tax rate on consumption is to include the *import* price wedge $p_m/p_y$ and the consumption tax rate $t_c$ in the total wedge. How do we deal with this?

First note that our main interest is not in the import price or the consumer tax elasticity of pay. In case of the inclusion of the import price wedge, the consumer price also enters the equation. Suppose $p_c$ is a combination of output price $p_y$ and the price of intermediate imports $p_m$ and the consumption tax rate $t_c$:

$$p_c = \left(\alpha p_y + (1-\alpha) p_m\right)(1+t_c) \tag{A.28}$$

where $0 < \alpha < 1$. Then:

$$\frac{p_y}{p_m} = \frac{(1-\alpha)\,(1+t_c)}{\frac{p_c}{p_y} - \alpha\,(1+t_c)} \tag{A.29}$$

Although (A.29) links the price wedge and the import price wedge, it is not straightforward to relate the estimated wage elasticities of $p_m/\,p_y$ and $p_c/\,p_y$. Therefore if the occasion arises we do not use the estimated coefficient of the import price wedge to construct price elasticities of pay.

## A.6 An example: single logarithmic forms

If wage equations are specified in the double logarithmic form (A.15) or (A.16) estimated coefficients are elasticities. If not, we need additional information on the size of economic variables like the unemployment rate or tax rates to compute elasticities. Nickell and Nunziata (2001) provide a very useful labour market institution data base. This contains information about the evolution of labour market variables like unemployment rate, replacement rate and tax rates in twenty OECD countries from 1960 to 1995. How do we apply these data?

Suppose we have a wage equation that contains the income tax rate and unemployment rate as explanatory variables, but not in log's:

$$\ln W = \ldots + \alpha_1 \tau_a + \alpha_2 u + \ldots \tag{A.30}$$

The unemployment elasticity of pay ( $\varepsilon_u$ ) can be obtained from:

$$\alpha_2 = \frac{\partial \ln W}{\partial u_r} = \frac{\partial \ln W}{\partial \ln u_r}\frac{\partial \ln u_r}{\partial u_r} = \frac{\varepsilon_u}{u} \tag{A.31}$$

And in case of the average retention rate $1-\tau_a$ :

$$\alpha_1 = \frac{\partial \ln W}{\partial \tau_a} = \frac{\partial \ln W}{\partial \ln(1-\tau_a)} \frac{\partial \ln(1-\tau_a)}{\partial \tau_a} = \frac{-\varepsilon_a}{1-\tau_a} \tag{A.32}$$

In (A.30) *u* equals some value of the unemployment rate; it is common to take the average value over the reported sample period, that can usually be computed from the Nickell and Nunziata (2001) OECD data base. Data on average tax or retention rates required to apply (A.24) are not included however, so they must be computed directly from OECD or National Accounts. In that case we take the value in the mid-year of the sample.

# Appendix B Dummy sample means

Table B.1 displays sample means of all dummies for each elasticity of pay. Ideally, the sample average is about 0.5, as this implies that the sample contains an equal number of both values (0 and 1). Very small (close to 0) or large (close to 1) indicate that there is not much variation in the dummy.

The final column ('mean') shows a weighted average using the number of observations (last row) as weights. To avoid spurious correlation a simple rule of thumb is applied to decide whether a dummy should be used as regressor. If the sample mean is smaller than 0.1 or the absolute number of nonzero values is less than 10, the dummy is excluded.

– able B.1 **Dummy sample means by type of elasticity of pay**

| | Elasticity of pay | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $q$ | 1+$s$ | $1-t_a$ | $1-t_m$ | $p_c$ | $p_y$ | ρ | $u$ | mean |
| The Netherlands dummy | 0.260 | 0.232 | 0.275 | 0.056 | 0.225 | 0.211 | 0.365 | 0.175 | 0.231 |
| Anglo Saxon dummy | 0.178 | 0.203 | 0.191 | 0.333 | 0.178 | 0.184 | 0.176 | 0.220 | 0.196 |
| Dummy Nordic countries | 0.178 | 0.304 | 0.260 | 0.222 | 0.248 | 0.316 | 0.297 | 0.229 | 0.256 |
| Publication dummy | 0.425 | 0.587 | 0.603 | 0.333 | 0.636 | 0.526 | 0.689 | 0.570 | 0.562 |
| Time series dummy | 1.000 | 0.978 | 0.939 | 0.833 | 0.953 | 0.987 | 0.959 | 0.942 | 0.962 |
| Single equation estimator | 0.582 | 0.587 | 0.435 | 0.111 | 0.473 | 0.553 | 0.703 | 0.520 | 0.532 |
| Hourly wage dummy | 0.144 | 0.239 | 0.160 | 0.111 | 0.194 | 0.178 | 0.257 | 0.318 | 0.217 |
| Bargaining dummy | 0.719 | 0.710 | 0.832 | 0.389 | 0.597 | 0.730 | 0.824 | 0.628 | 0.700 |
| Union density | 0.021 | 0.065 | 0.076 | 0.056 | 0.047 | 0.046 | 0.108 | 0.049 | 0.054 |
| First difference estimation | 0.082 | 0.087 | 0.168 | 0.000 | 0.171 | 0.138 | 0.000 | 0.004 | 0.089 |
| Level estimation | 0.205 | 0.239 | 0.267 | 0.167 | 0.194 | 0.197 | 0.365 | 0.161 | 0.217 |
| ADL dummy | 0.712 | 0.674 | 0.565 | 0.833 | 0.636 | 0.664 | 0.635 | 0.834 | 0.694 |
| Sector dummy | 0.247 | 0.406 | 0.382 | 0.222 | 0.318 | 0.342 | 0.486 | 0.247 | 0.326 |
| Time dummy 1950 - 1969 | 0.021 | 0.029 | 0.038 | 0.000 | 0.062 | 0.026 | 0.014 | 0.022 | 0.030 |
| Time dummy 1990 - 2008 | 0.233 | 0.152 | 0.122 | 0.222 | 0.070 | 0.138 | 0.095 | 0.260 | 0.168 |
| F dummy labour productivity | 0.644 | 0.362 | 0.458 | 0.611 | 0.411 | 0.395 | 0.432 | 0.323 | 0.427 |
| F dummy payroll tax | 0.205 | 0.391 | 0.359 | 0.667 | 0.271 | 0.289 | 0.243 | 0.166 | 0.274 |
| F dummy average retention rate | 0.370 | 0.449 | 0.649 | 0.611 | 0.465 | 0.487 | 0.392 | 0.242 | 0.424 |
| F dummy marginal retention rate | 0.096 | 0.109 | 0.107 | 0.833 | 0.109 | 0.092 | 0.041 | 0.054 | 0.100 |
| F dummy consumer price | 0.267 | 0.312 | 0.382 | 0.111 | 0.597 | 0.316 | 0.351 | 0.220 | 0.330 |
| F dummy producer price | 0.329 | 0.355 | 0.504 | 0.111 | 0.403 | 0.474 | 0.419 | 0.206 | 0.362 |
| F dummy replacement rate | 0.342 | 0.370 | 0.336 | 0.167 | 0.248 | 0.362 | 0.973 | 0.287 | 0.367 |
| F dummy unemployment rate | 0.836 | 0.768 | 0.672 | 0.722 | 0.659 | 0.763 | 0.892 | 0.987 | 0.807 |
| R dummy labour productivity | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| R dummy payroll tax | 0.116 | 0.297 | 0.305 | 0.222 | 0.171 | 0.151 | 0.203 | 0.139 | 0.191 |
| R dummy average retention rate | 0.116 | 0.283 | 0.328 | 0.333 | 0.155 | 0.151 | 0.216 | 0.143 | 0.194 |
| R dummy marginal retention ratio | 0.000 | 0.007 | 0.023 | 0.167 | 0.000 | 0.000 | 0.000 | 0.004 | 0.008 |
| R dummy consumer price | 0.096 | 0.174 | 0.191 | 0.667 | 0.209 | 0.178 | 0.041 | 0.090 | 0.150 |
| R dummy producer price | 0.096 | 0.167 | 0.183 | 0.667 | 0.194 | 0.171 | 0.054 | 0.090 | 0.146 |
| R dummy replacement ratio | 0.000 | 0.000 | 0.008 | 0.000 | 0.008 | 0.007 | 0.014 | 0.004 | 0.005 |
| R dummy unemployment rate | 0.000 | 0.000 | 0.000 | 0.000 | 0.023 | 0.000 | 0.000 | 0.013 | 0.006 |
| C dummy labour productivity | 0.356 | 0.261 | 0.107 | 0.167 | 0.062 | 0.309 | 0.257 | 0.224 | 0.227 |
| C dummy payroll tax | 0.267 | 0.312 | 0.130 | 0.000 | 0.124 | 0.257 | 0.257 | 0.170 | 0.209 |
| C dummy average retention ratio | 0.021 | 0.022 | 0.023 | 0.000 | 0.008 | 0.013 | 0.014 | 0.009 | 0.015 |
| C dummy marginal retention ratio | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| C dummy consumer price | 0.055 | 0.043 | 0.046 | 0.000 | 0.194 | 0.013 | 0.054 | 0.085 | 0.069 |
| C dummy producer price | 0.308 | 0.246 | 0.069 | 0.000 | 0.000 | 0.355 | 0.297 | 0.224 | 0.212 |
| C dummy replacement rate | 0.007 | 0.007 | 0.008 | 0.000 | 0.000 | 0.007 | 0.014 | 0.004 | 0.006 |
| C dummy unemployment rate | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | | | | | | | | |
| Number of observations | 146 | 138 | 131 | 18 | 129 | 152 | 74 | 223 | |

# Appendix C Regression results

This appendix presents regression results by type of elasticity. Each table contains both LAD and OLS estimates. The set of dummy variables is as complete as possible; if a dummy included a few positive values only, it is omitted (see also appendix C).

## Labour productivity

Table C.1 summarizes the regression results.

**Table C.1 Labour productivity elasticity of wages**

| | LAD regressions | | | OLS regressions | | |
|---|---|---|---|---|---|---|
| | coefficient | std. error | p - value | coefficient | std. error | p - value |
| Constant | 0.721 | 0.184 | 0.000 | 0.742 | 0.078 | 0.000 |
| The Netherlands dummy | – 0.089 | 0.073 | 0.225 | – 0.091 | 0.056 | 0.104 |
| Anglo Saxon dummy | 0.000 | 0.039 | 1.000 | 0.009 | 0.032 | 0.771 |
| Dummy Nordic countries | 0.000 | 0.054 | 1.000 | 0.050 | 0.050 | 0.320 |
| Publication dummy | 0.015 | 0.046 | 0.749 | 0.020 | 0.037 | 0.599 |
| Single equation estimator | 0.015 | 0.051 | 0.772 | 0.047 | 0.037 | 0.212 |
| Hourly wage dummy | 0.010 | 0.054 | 0.853 | 0.103 | 0.052 | 0.050 |
| Bargaining dummy | – 0.010 | 0.051 | 0.844 | – 0.040 | 0.043 | 0.348 |
| First difference estimation | – 0.018 | 0.157 | 0.909 | – 0.099 | 0.095 | 0.300 |
| Level estimation | 0.010 | 0.088 | 0.910 | – 0.017 | 0.057 | 0.769 |
| Sector dummy | 0.010 | 0.065 | 0.878 | – 0.016 | 0.051 | 0.760 |
| F dummy payroll tax | 0.045 | 0.081 | 0.574 | 0.023 | 0.070 | 0.743 |
| F dummy average retention rate | 0.069 | 0.086 | 0.426 | 0.161 | 0.068 | 0.020 |
| F dummy marginal retention rate | 0.145 | 0.181 | 0.426 | 0.078 | 0.100 | 0.442 |
| F dummy consumer price | – 0.080 | 0.069 | 0.246 | 0.016 | 0.082 | 0.841 |
| F dummy producer price | 0.091 | 0.092 | 0.326 | 0.020 | 0.090 | 0.821 |
| F dummy replacement rate | – 0.035 | 0.060 | 0.561 | – 0.068 | 0.044 | 0.124 |
| F dummy unemployment rate | 0.085 | 0.125 | 0.499 | – 0.005 | 0.059 | 0.929 |
| R dummy payroll tax | 0.048 | 0.195 | 0.806 | – 0.191 | 0.125 | 0.130 |
| R dummy average retention rate | 0.061 | 0.194 | 0.753 | 0.310 | 0.136 | 0.024 |
| R dummy consumer price | – 0.035 | 0.156 | 0.823 | – 0.183 | 0.129 | 0.159 |
| R dummy producer price | – 0.029 | 0.238 | 0.902 | 0.168 | 0.140 | 0.234 |
| C dummy labour productivity | 0.124 | 0.079 | 0.119 | 0.229 | 0.051 | 0.000 |
| C dummy payroll tax | – 0.010 | 0.070 | 0.886 | – 0.049 | 0.052 | 0.349 |
| C dummy consumer price | 0.080 | 0.104 | 0.441 | 0.041 | 0.063 | 0.517 |
| C dummy producer price | 0.065 | 0.099 | 0.510 | 0.004 | 0.064 | 0.954 |
| $\overline{R}^2$ | 0.312 | | | 0.457 | | |
| S.E. of regression | 0.169 | | | 0.344 | | |
| median value dependent variable | 0.175 | | | 0.161 | | |
| Mean dependent variable | 1.000 | | | | | |
| SD dependent var | 0.199 | | | | | |
| Objective | 6.901 | | | 3.105 | | |
| Observations | 146 | | | 146 | | |

The time series dummy has been omitted as all reported elasticities have been estimated using time series data. Figure 4.1. already showed that elasticities are rather symmetrically distributed around the mean value. The results of table C.1 are in line with this observation: the size of the general constant is close to the sample mean and its standard error is small. Country dummies do not matter at all, save the dummy for The Netherlands that suggests a small negative correction. The coefficients of the restriction dummies (F, R, and C) of income tax variables and prices suggest that a more complete wage equation may yield other labour productivity elasticities. The coefficient of the C dummy of labour productivity indicates that if the elasticity is fixed a priori (in this case, at a value of 1) then this yields a higher elasticity than in case of a free estimate. OLS regressions are in line with these findings, although in this case the contribution of the hourly wage dummy is more pronounced.

### Payroll taxes

Figure 4.2 shows that there is a peak in computed elasticities at a value of 1, a value at which an increase in payroll taxes is fully shifted to the employees. This a common feature of wage equations that take wage costs as the endogenous variable. Therefore we may expect a significant impact of the C Dummy of payroll taxes. Table C.2 summarizes outcomes for the payroll tax elasticity. The fit is much better than in case of labour productivity, but the most striking result is the importance of the first difference dummy. The estimated coefficient indicates a substantial difference between short and long term elasticities. The figures in the table also confirm that the impact of the C dummy of payroll taxes is considerable and significant. Also here, it matters how price ant tax variables enter the wage equation. The C dummies of $p_c$ and $p_y$ are substantial and opposite in sign; clearly it matters which of the two is used to deflate wages. To sum up: short run elasticities are much smaller in absolute value than their long run counterparts. An increase in payroll taxes cannot immediately and completely be shifted towards employees. Second, wage equations that do not impose any restrictions on payroll taxes (R and C dummies equal 0) yield values of wage elasticities that are smaller in absolute value. Finally, the choice of the deflator matters.

| Table C.2 | Payroll tax elasticity of wages | | | | | |
|---|---|---|---|---|---|---|
| | LAD regressions | | | OLS regressions | | |
| | coefficient | std. error | p - value | coefficient | std. error | p - value |
| Constant | – 0.458 | 0.328 | 0.166 | – 0.400 | 0.193 | 0.041 |
| The Netherlands dummy | – 0.049 | 0.099 | 0.622 | – 0.068 | 0.096 | 0.480 |
| Anglo Saxon dummy | 0.010 | 0.084 | 0.910 | – 0.034 | 0.068 | 0.615 |
| Dummy Nordic countries | – 0.021 | 0.078 | 0.790 | – 0.145 | 0.079 | 0.070 |
| Publication dummy | 0.090 | 0.078 | 0.250 | 0.201 | 0.068 | 0.004 |
| Time series dummy | – 0.126 | 0.179 | 0.483 | – 0.101 | 0.141 | 0.475 |
| Single equation estimator | – 0.027 | 0.104 | 0.791 | 0.093 | 0.061 | 0.128 |
| Hourly wage dummy | – 0.120 | 0.075 | 0.115 | – 0.094 | 0.061 | 0.123 |
| Bargaining dummy | – 0.007 | 0.061 | 0.906 | – 0.052 | 0.073 | 0.480 |
| Union density | – 0.024 | 0.094 | 0.801 | 0.015 | 0.082 | 0.854 |
| First difference estimation | 0.393 | 0.160 | 0.016 | 0.480 | 0.153 | 0.002 |
| Level estimation | – 0.002 | 0.099 | 0.982 | – 0.098 | 0.092 | 0.288 |
| Sector dummy | 0.076 | 0.084 | 0.367 | 0.073 | 0.065 | 0.261 |
| F dummy labour productivity | – 0.001 | 0.088 | 0.987 | 0.032 | 0.093 | 0.733 |
| F dummy average retention rate | – 0.086 | 0.093 | 0.354 | – 0.137 | 0.103 | 0.186 |
| F dummy marginal retention rate | – 0.064 | 0.228 | 0.779 | 0.045 | 0.110 | 0.683 |
| F dummy consumer price | 0.046 | 0.097 | 0.641 | – 0.076 | 0.103 | 0.464 |
| F dummy producer price | – 0.138 | 0.102 | 0.178 | 0.035 | 0.112 | 0.758 |
| F dummy replacement rate | – 0.018 | 0.044 | 0.683 | – 0.050 | 0.043 | 0.247 |
| F dummy unemployment rate | – 0.022 | 0.071 | 0.755 | – 0.087 | 0.070 | 0.218 |
| R dummy payroll tax | – 0.010 | 0.146 | 0.945 | – 0.075 | 0.109 | 0.494 |
| R dummy average retention rate | – 0.046 | 0.171 | 0.789 | – 0.036 | 0.159 | 0.823 |
| R dummy consumer price | 0.470 | 0.241 | 0.054 | 0.053 | 0.222 | 0.812 |
| R dummy producer price | – 0.212 | 0.238 | 0.375 | 0.122 | 0.235 | 0.604 |
| C dummy labour productivity | 0.092 | 0.101 | 0.364 | 0.194 | 0.119 | 0.107 |
| C dummy payroll tax | – 0.293 | 0.079 | 0.000 | – 0.409 | 0.067 | 0.000 |
| C dummy consumer price | 0.330 | 0.202 | 0.105 | 0.316 | 0.175 | 0.073 |
| C dummy producer price | – 0.166 | 0.127 | 0.193 | – 0.192 | 0.105 | 0.070 |
| | | | | | | |
| Adjusted R-squared | 0.413 | | | 0.536 | | |
| S.E. of regression | 0.252 | | | 0.220 | | |
| Median value dependent variable | – 0.720 | | | | | |
| Mean dependent variable | – 0.659 | | | | | |
| SD dependent var | 0.323 | | | | | |
| Objective | 9.168 | | | 5.319 | | |
| Observations | 128 | | | 128 | | |

## Average income retention rate

Regression results for the elasticity of the average retention rate are in table C.3.

| **Table C.3** | **Average income retention rate elasticity of wages ( $\varepsilon_{1-a}$ )** | | | | | |
|---|---|---|---|---|---|---|
| | LAD regressions | | | OLS regressions | | |
| | coefficient | std. error | p - value | coefficient | std. error | p - value |
| Constant | – 0.043 | 0.232 | 0.854 | 0.013 | 0.155 | 0.931 |
| The Netherlands dummy | 0.074 | 0.121 | 0.546 | 0.076 | 0.068 | 0.268 |
| Anglo Saxon dummy | – 0.061 | 0.148 | 0.679 | – 0.039 | 0.081 | 0.631 |
| Dummy Nordic countries | – 0.120 | 0.152 | 0.432 | 0.005 | 0.075 | 0.943 |
| Publication dummy | – 0.259 | 0.123 | 0.037 | – 0.215 | 0.066 | 0.002 |
| Time series dummy | – 0.282 | 0.221 | 0.205 | – 0.342 | 0.133 | 0.012 |
| Single equation estimator | – 0.180 | 0.099 | 0.072 | – 0.198 | 0.065 | 0.003 |
| Hourly wage dummy | 0.163 | 0.126 | 0.199 | 0.090 | 0.088 | 0.310 |
| Bargaining dummy | 0.119 | 0.152 | 0.435 | 0.137 | 0.085 | 0.110 |
| First difference estimation | – 0.222 | 0.163 | 0.175 | – 0.208 | 0.110 | 0.061 |
| Level estimation | 0.170 | 0.118 | 0.153 | 0.144 | 0.077 | 0.065 |
| Sector dummy | 0.035 | 0.086 | 0.686 | – 0.087 | 0.066 | 0.190 |
| F dummy labour productivity | 0.084 | 0.098 | 0.395 | 0.017 | 0.060 | 0.771 |
| F dummy payroll tax | – 0.008 | 0.117 | 0.947 | 0.007 | 0.086 | 0.935 |
| F dummy marginal retention rate | – 0.101 | 0.210 | 0.630 | – 0.035 | 0.120 | 0.773 |
| F dummy consumer price | 0.113 | 0.176 | 0.522 | 0.105 | 0.082 | 0.203 |
| F dummy producer price | – 0.121 | 0.096 | 0.209 | – 0.130 | 0.063 | 0.042 |
| F dummy replacement rate | – 0.018 | 0.120 | 0.881 | 0.034 | 0.065 | 0.608 |
| F dummy unemployment rate | 0.124 | 0.146 | 0.398 | 0.096 | 0.068 | 0.156 |
| R dummy payroll tax | – 0.024 | 0.172 | 0.887 | – 0.101 | 0.098 | 0.302 |
| R dummy average retention rate | – 0.099 | 0.161 | 0.542 | 0.011 | 0.084 | 0.899 |
| R dummy consumer price | 0.239 | 0.420 | 0.571 | 0.182 | 0.184 | 0.327 |
| R dummy producer price | – 0.313 | 0.450 | 0.489 | – 0.248 | 0.199 | 0.216 |
| C dummy labour productivity | – 0.040 | 0.177 | 0.821 | – 0.135 | 0.107 | 0.212 |
| C dummy payroll tax | – 0.035 | 0.158 | 0.828 | 0.123 | 0.109 | 0.261 |
| $\overline{R}^2$ | 0.163 | | | 0.280 | | |
| S.E. of regression | 0.249 | | | 0.235 | | |
| Median value dependent variable | – 0.368 | | | | | |
| Mean dependent variable | – 0.390 | | | | | |
| SD dependent var | 0.277 | | | | | |
| Objective | 10.690 | | | 5.847 | | |
| Observations | 131 | | | 131 | | |

It is not very surprising that here, like in the case of payroll taxes short term elasticities significantly differ from their long term values. In this case however, short run elasticities are larger in absolute value than their long run equivalents. The coefficient of the level estimation dummy shows that wage equations that have been estimated in levels (i.e. without any dynamics) yield smaller (absolute) values of the income tax elasticity. The coefficient of the C dummy of the consumer price indicates that tax elasticities obtained from real wage equations are larger in absolute value. Recall that the C dummy equals 1 if the elasticity is fixed; in case of the consumer price this value always equals 1.

## Marginal income retention rate

Here our sample is very limited: 18 observations only. In this rather small sample the use of dummy variables is limited as they probably are highly correlated. Therefore in Table C.4 we present two reduced regressions using a general constant and 3 country dummies only. The Anglo Saxon dummy absorbs the large residual resulting from Lockwood and Manning (1993), who report a value of 0.65. Similarly, the country dummy for The Netherlands indicates the impact of Graafland et al (1999) and Peeters and den Reijer (2001, 2002).

**Table C.4 Marginal Income tax elasticity of pay ( $\varepsilon_{1-m}$ )**

| | Least Absolute deviations | | | OLS regressions | | |
|---|---|---|---|---|---|---|
| | coefficient | std. error | p - value | coefficient | std. error | p - value |
| Constant | 0.011 | 0.188 | 0.954 | 0.149 | 0.111 | 0.201 |
| The Netherlands dummy | 0.261 | 0.410 | 0.535 | 0.122 | 0.111 | 0.290 |
| Anglo Saxon Dummy | 0.189 | 0.267 | 0.490 | 0.128 | 0.158 | 0.430 |
| Dummy Nordic countries | 0.235 | 0.278 | 0.412 | 0.123 | 0.152 | 0.430 |
| $\overline{R}^2$ | – 0.008 | | | – 0.134 | | |
| Mean value | 0.226 | | | 0.226 | | |
| Standard error | 0.245 | | | 0.245 | | |
| Median value | 0.200 | | | 0.200 | | |
| Objective | 1.569 | | | 0.953 | | |
| Observations | 18 | | | 18 | | |

The results indicate the sample is to small to draw solid general conclusions, except one: the sample mean (or median) is possibly the best guess of the correct value (see also section 6).

## Output prices

Table C.5 summarizes outcomes for the output price elasticity. The equation fits rather well, both for LAD and OLS estimates. From the table four conclusions emerge. First, wage equations estimated with times series data yield substantially lower output price elasticities than those regressed on panel or cross section data. Second, elasticities based on sector analysis are lower than their macro equivalents. Third, the results also suggest that level estimation (that does not account for any dynamics) produces lower elasticities. The most important result however is the dependence of the output price elasticity on the way the consumer price enters the wage equation. All restriction dummies (F, R, and C) related to $p_c$ have a considerable impact on the size of the output price elasticity.

| Table C.5 | Output price elasticity of wages | | | | | |
|---|---|---|---|---|---|---|
| | LAD regressions | | | OLS regressions | | |
| | coefficient | std. error | p - value | coefficient | std. error | p - value |
| Constant | 1.467 | 0.340 | 0.000 | 1.249 | 0.266 | 0.000 |
| The Netherlands dummy | – 0.057 | 0.064 | 0.372 | – 0.034 | 0.058 | 0.554 |
| Anglo Saxon dummy | 0.000 | 0.043 | 1.000 | 0.039 | 0.051 | 0.445 |
| Dummy Nordic countries | 0.099 | 0.066 | 0.137 | 0.040 | 0.057 | 0.488 |
| Publication dummy | – 0.070 | 0.045 | 0.124 | – 0.081 | 0.038 | 0.033 |
| Time series dummy | – 0.562 | 0.418 | 0.181 | – 0.276 | 0.269 | 0.306 |
| Single equation estimator | – 0.072 | 0.083 | 0.388 | – 0.109 | 0.044 | 0.014 |
| Hourly wage dummy | 0.038 | 0.048 | 0.427 | 0.068 | 0.041 | 0.098 |
| Bargaining dummy | – 0.022 | 0.095 | 0.821 | 0.011 | 0.050 | 0.832 |
| Dummy union density | – 0.135 | 0.197 | 0.493 | – 0.236 | 0.107 | 0.030 |
| First difference estimation | – 0.059 | 0.101 | 0.557 | – 0.177 | 0.093 | 0.060 |
| Level estimation | – 0.065 | 0.135 | 0.632 | – 0.080 | 0.081 | 0.326 |
| Sector dummy | – 0.120 | 0.078 | 0.128 | – 0.159 | 0.048 | 0.001 |
| Time dummy 1990 - 2008 | – 0.017 | 0.095 | 0.854 | 0.029 | 0.048 | 0.554 |
| F dummy labour productivity | 0.151 | 0.078 | 0.055 | 0.099 | 0.052 | 0.062 |
| F dummy payroll tax | – 0.151 | 0.092 | 0.104 | – 0.152 | 0.056 | 0.007 |
| F dummy average retention rate | 0.137 | 0.086 | 0.112 | 0.116 | 0.057 | 0.043 |
| F dummy marginal retention rate | – 0.054 | 0.106 | 0.613 | – 0.129 | 0.083 | 0.121 |
| F dummy consumer price | – 0.427 | 0.076 | 0.000 | – 0.332 | 0.064 | 0.000 |
| F dummy replacement rate | 0.032 | 0.051 | 0.526 | 0.057 | 0.042 | 0.176 |
| F dummy unemployment rate | – 0.171 | 0.081 | 0.036 | – 0.218 | 0.053 | 0.000 |
| R dummy payroll tax | – 0.145 | 0.166 | 0.384 | – 0.179 | 0.166 | 0.281 |
| R dummy average retention rate | 0.172 | 0.167 | 0.303 | 0.124 | 0.164 | 0.449 |
| R dummy consumer price | – 0.585 | 0.135 | 0.000 | – 0.319 | 0.189 | 0.093 |
| R dummy producer price | 0.269 | 0.142 | 0.061 | 0.097 | 0.188 | 0.606 |
| C dummy labour productivity | 0.189 | 0.071 | 0.009 | 0.150 | 0.057 | 0.009 |
| C dummy payroll tax | – 0.039 | 0.060 | 0.515 | – 0.035 | 0.040 | 0.381 |
| C dummy producer price | 0.188 | 0.058 | 0.002 | 0.209 | 0.044 | 0.000 |
| $\overline{R}^2$ | 0.607 | | | 0.763 | | |
| S.E. of regression | 0.199 | | | 0.177 | | |
| Median value dependent variable | 0.744 | | | | | |
| Mean value dependent vriable | 0.657 | | | | | |
| Objective | 8.292 | | | 4.275 | | |
| Observations | 152 | | | 152 | | |

## Consumer price

Table C.6 summarizes outcomes for the consumer price elasticity. Inclusion of dummies does not explain that much variation in elasticities. In all regressions the general constant is highly significant but this does not explain much, however.

The use of simultaneous estimation techniques (e.g. to take endogeneity of prices into account) produces lower consumer price elasticities of pay. Table C.10 shows that the inclusion of the output price has a substantial and significant impact on reported estimates. This finding is consistent with earlier conclusions. We may conclude that if one of the prices $p_y$ or $p_c$ is omitted from the wage equation, the elasticity of the remaining price is biased upwards.

The C Dummy corresponding to the output price is zero everywhere and has been omitted. Like in case of the output price elasticity, R dummies of $p_c$ and $p_y$ and of $1+s$ and $1-t_a$ are highly correlated.

**Table C.6 Consumer price elasticity of wages**

| | LAD regressions | | | OLS regressions | | |
|---|---|---|---|---|---|---|
| | coefficient | std. error | p - value | coefficient | std. error | p - value |
| Constant | 0.631 | 0.157 | 0.000 | 0.611 | 0.118 | 0.000 |
| The Netherlands dummy | 0.004 | 0.086 | 0.963 | – 0.068 | 0.069 | 0.329 |
| Anglo Saxon dummy | 0.000 | 0.086 | 1.000 | – 0.136 | 0.075 | 0.071 |
| Dummy Nordic countries | – 0.060 | 0.077 | 0.438 | – 0.048 | 0.073 | 0.516 |
| Publication dummy | 0.086 | 0.080 | 0.286 | 0.098 | 0.063 | 0.120 |
| Time series dummy | – 0.007 | 0.115 | 0.950 | – 0.012 | 0.093 | 0.895 |
| Single equation estimator | 0.161 | 0.085 | 0.062 | 0.216 | 0.056 | 0.000 |
| Hourly wage dummy | 0.027 | 0.100 | 0.791 | 0.050 | 0.072 | 0.491 |
| Bargaining dummy | 0.122 | 0.109 | 0.267 | 0.066 | 0.058 | 0.261 |
| First difference estimation | 0.041 | 0.177 | 0.817 | 0.012 | 0.087 | 0.891 |
| Level estimation | – 0.116 | 0.158 | 0.465 | – 0.021 | 0.099 | 0.830 |
| Sector dummy | 0.120 | 0.099 | 0.230 | 0.078 | 0.072 | 0.284 |
| F dummy labour productivity | – 0.060 | 0.119 | 0.615 | – 0.021 | 0.062 | 0.732 |
| F dummy payroll tax | 0.084 | 0.169 | 0.619 | 0.106 | 0.093 | 0.253 |
| F dummy average retention rate | – 0.004 | 0.146 | 0.978 | – 0.061 | 0.076 | 0.425 |
| F dummy marginal retention rate | 0.027 | 0.160 | 0.864 | 0.101 | 0.108 | 0.352 |
| F dummy producer price | – 0.307 | 0.151 | 0.044 | – 0.195 | 0.107 | 0.072 |
| F dummy replacement rate | – 0.153 | 0.123 | 0.214 | – 0.149 | 0.076 | 0.053 |
| F dummy unemployment rate | 0.153 | 0.063 | 0.017 | 0.112 | 0.049 | 0.024 |
| R dummy payroll tax | – 0.257 | 0.191 | 0.182 | – 0.130 | 0.133 | 0.332 |
| R dummy average retention rate | 0.269 | 0.146 | 0.068 | 0.137 | 0.118 | 0.246 |
| R dummy consumer price | – 0.058 | 0.184 | 0.752 | – 0.185 | 0.127 | 0.148 |
| R dummy producer price | – 0.267 | 0.217 | 0.221 | – 0.081 | 0.161 | 0.615 |
| C dummy labour productivity | – 0.028 | 0.165 | 0.864 | – 0.006 | 0.094 | 0.953 |
| C dummy payroll tax | 0.060 | 0.173 | 0.731 | 0.011 | 0.087 | 0.899 |
| C dummy consumer price | 0.129 | 0.086 | 0.137 | 0.178 | 0.072 | 0.015 |
| $\overline{R}^2$ | 0.304 | | | 0.442 | | |
| S.E. of regression | 0.220 | | | 0.204 | | |
| Median value dependent variable | 0.790 | | | 0.790 | | |
| Mean dependent variable | 0.725 | | | 0.725 | | |
| SD dependent variable | 0.273 | | | 0.273 | | |
| Objective | 8.162 | | | 5.454 | | |
| Observations | 129 | | | 129 | | |

## Replacement ratio

In this section we add the level of unemployment to our regression to test the hypothesis that the replacement ratio elasticity of pay is smaller when unemployment is low. With low unemployment, spells of inactivity are relatively short and the unemployment benefit level will exert only a small impact on the alternative wage (Graafland *et al* (2001)).

**Table C.7 Replacement rate elasticity of wages**

| | LAD regressions | | | OLS regressions | | |
|---|---|---|---|---|---|---|
| | coefficient | std. error | p - value | coefficient | std. error | p - value |
| Constant | – 0.354 | 0.464 | 0.449 | – 0.770 | 0.349 | 0.033 |
| The Netherlands dummy | 0.104 | 0.131 | 0.432 | 0.170 | 0.112 | 0.138 |
| Anglo Saxon dummy | – 0.037 | 0.163 | 0.822 | – 0.136 | 0.104 | 0.195 |
| Dummy Nordic countries | – 0.059 | 0.166 | 0.726 | – 0.095 | 0.132 | 0.474 |
| Publication dummy | 0.181 | 0.167 | 0.282 | 0.189 | 0.100 | 0.064 |
| Time series dummy | 0.486 | 0.275 | 0.084 | 0.662 | 0.227 | 0.006 |
| Single equation estimator | 0.069 | 0.200 | 0.731 | 0.207 | 0.098 | 0.040 |
| Hourly wage dummy | – 0.186 | 0.206 | 0.373 | – 0.058 | 0.106 | 0.587 |
| Bargaining dummy | 0.081 | 0.141 | 0.567 | 0.076 | 0.108 | 0.484 |
| Level estimation | – 0.069 | 0.162 | 0.673 | – 0.172 | 0.126 | 0.178 |
| Sector dummy | 0.147 | 0.193 | 0.448 | 0.121 | 0.091 | 0.188 |
| F dummy labour productivity | 0.043 | 0.159 | 0.786 | – 0.051 | 0.117 | 0.666 |
| F dummy payroll tax | – 0.330 | 0.155 | 0.038 | – 0.192 | 0.108 | 0.083 |
| F dummy average retention rate | 0.107 | 0.163 | 0.516 | 0.148 | 0.119 | 0.217 |
| F dummy marginal retention rate | 0.036 | 0.225 | 0.875 | 0.011 | 0.174 | 0.948 |
| F dummy consumer price | 0.050 | 0.219 | 0.820 | 0.039 | 0.119 | 0.748 |
| F dummy producer price | – 0.110 | 0.183 | 0.551 | – 0.113 | 0.134 | 0.403 |
| F dummy unemployment rate | – 0.071 | 0.210 | 0.737 | 0.054 | 0.107 | 0.615 |
| R dummy payroll tax | – 0.688 | 0.317 | 0.035 | – 0.699 | 0.211 | 0.002 |
| R dummy average retention rate | 0.539 | 0.392 | 0.176 | 0.616 | 0.220 | 0.007 |
| R dummy consumer price | – 0.450 | 0.418 | 0.288 | – 0.667 | 0.267 | 0.016 |
| R dummy producer price | 0.187 | 0.336 | 0.581 | 0.347 | 0.211 | 0.107 |
| C dummy labour productivity | 0.192 | 0.196 | 0.331 | – 0.025 | 0.161 | 0.876 |
| C dummy payroll tax | – 0.140 | 0.179 | 0.439 | – 0.089 | 0.120 | 0.463 |
| C dummy consumer price | 0.081 | 0.352 | 0.818 | 0.095 | 0.142 | 0.509 |
| C dummy producer price | 0.057 | 0.150 | 0.705 | 0.115 | 0.119 | 0.338 |
| Volume unemployment rate | 0.007 | 0.019 | 0.695 | 0.026 | 0.014 | 0.070 |
| $\overline{R}^2$ | 0.119 | | | 0.371 | | |
| S.E. of regression | 0.250 | | | 0.218 | | |
| Median value dependent variable | 0.322 | | | 0.322 | | |
| Mean dependent variable | 0.349 | | | 0.349 | | |
| SD dependent var | 0.274 | | | 0.274 | | |
| Objective | 4.303 | | | 2.129 | | |
| Observations | 74 | | | 74 | | |

Table C.7 summarizes outcomes. The average level of the unemployment rate (expressed as % of the working population) has a small positive impact on the estimated elasticity. The sample mean of the time series dummy is close to 1 so its coefficient compensates the negative general constant. The sector dummy has an important positive impact on estimated elasticities: its value is 0.24 higher than the one based on aggregate data. This is possibly due to the fallback position: in sectoral regressions this not only includes unemployment or welfare benefits, but also an opportunity wage that can be earned in other sectors. Employers in a specific sector have to offer their employees higher wages if wages in the rest of the economy increase to prevent job quitting. So the elasticity may be higher than can be expected on basis of a pure macro benefit based replacement ratio.

The R dummies of the tax variables $1+s$ and $1-t_a$ are highly correlated; but the net impact of both R dummies on the replacement rate elasticity is small.

## Unemployment rate

In this case there are three questions. First, does the wage equation have a macro economic counterpart that links real macro wages to aggregate unemployment rates? Second, can we attribute cross study variations in reported unemployment elasticities of pay to variations in our moderator variables or does the elasticity simply obey an 'empirical law of economics' (Card(1995))? Finally, we also want to investigate whether the level of the replacement ratio has an impact on reported values of the unemployment elasticity of pay. If the replacement ratio increases we expect the impact of unemployment on wages to decline. Job seekers are less likely to accept a lower wage offer when the replacement ratio is high.

To answer the third question, we have to link each unemployment elasticity of pay to an average level of the replacement ratio in the same publication. For a number of observations however, no levels of the replacement ratio were available, notably in case of (former) transition economies (Poland, Romania, Hungary and Bulgaria). Also, a small number of unemployment elasticities corresponds to groups of OECD countries. Indeed, it is possible to aggregate replacement ratios over OECD countries using country data on average wages, income retention rates, average unemployment ratio's and total employment. This is a rather time consuming process however, while it adds no more than 4 observations to the total of over 200.

Therefore we proceed in two steps. First, we run regressions using only unemployment elasticities that can be linked to an average replacement ratio (a sample of 199 observations). If the volume of the replacement ratio does not contribute much to the explanation of the variation in our sample, we will omit it from the regressions and use the full sample of 223 data points. The results of the first step indicate that the coefficient of the level of the replacement ratio doesn't have the expected sign: a higher replacement ratio increases the absolute value of the unemployment elasticity of pay. This result is independent of the estimation technique; if we use OLS the estimated coefficient is even significantly different from zero at the 5% level. Therefore we proceed with the second step and omit the level of the average replacement rate from the equation. Table C.8 reports the result for the full sample of 223 observations.

**Table C.8 Unemployment rate elasticity of wages**

| | LAD regressions | | | OLS regressions | | |
|---|---|---|---|---|---|---|
| | coefficient | std. error | p - value | coefficient | std. error | p - value |
| Constant | – 0.053 | 0.036 | 0.145 | – 0.091 | 0.032 | 0.005 |
| The Netherlands dummy | – 0.001 | 0.017 | 0.952 | – 0.005 | 0.023 | 0.839 |
| Anglo Saxon dummy | 0.037 | 0.018 | 0.044 | 0.038 | 0.018 | 0.036 |
| Dummy Nordic countries | – 0.011 | 0.023 | 0.624 | – 0.001 | 0.019 | 0.952 |
| Publication dummy | – 0.008 | 0.020 | 0.703 | – 0.003 | 0.019 | 0.873 |
| Time series dummy | – 0.032 | 0.031 | 0.308 | – 0.009 | 0.029 | 0.751 |
| Single equation estimator | 0.003 | 0.016 | 0.839 | 0.021 | 0.016 | 0.198 |
| Hourly wage dummy | 0.008 | 0.025 | 0.744 | – 0.018 | 0.019 | 0.344 |
| Bargaining dummy | 0.005 | 0.017 | 0.775 | – 0.019 | 0.018 | 0.286 |
| Level estimation | – 0.002 | 0.036 | 0.949 | – 0.005 | 0.020 | 0.799 |
| Sector dummy | 0.013 | 0.020 | 0.521 | 0.022 | 0.018 | 0.242 |
| Time dummy 1990 - 2008 | 0.013 | 0.017 | 0.426 | 0.017 | 0.019 | 0.367 |
| F dummy labour productivity | 0.017 | 0.021 | 0.430 | 0.019 | 0.024 | 0.425 |
| F dummy payroll tax | – 0.022 | 0.024 | 0.366 | – 0.001 | 0.022 | 0.949 |
| F dummy average retention rate | – 0.009 | 0.033 | 0.783 | – 0.013 | 0.024 | 0.591 |
| F dummy marginal retention rate | – 0.068 | 0.056 | 0.226 | – 0.071 | 0.046 | 0.120 |
| F dummy consumer price | 0.030 | 0.019 | 0.116 | 0.041 | 0.017 | 0.015 |
| F dummy producer price | 0.019 | 0.021 | 0.366 | 0.028 | 0.019 | 0.150 |
| F dummy replacement rate | – 0.006 | 0.017 | 0.710 | – 0.014 | 0.016 | 0.399 |
| R dummy payroll tax | 0.004 | 0.038 | 0.921 | 0.035 | 0.038 | 0.357 |
| R dummy average retention rate | – 0.023 | 0.034 | 0.504 | – 0.033 | 0.035 | 0.344 |
| R dummy consumer price | – 0.002 | 0.055 | 0.969 | 0.030 | 0.036 | 0.400 |
| R dummy producer price | – 0.038 | 0.083 | 0.648 | – 0.064 | 0.040 | 0.107 |
| C dummy labour productivity | – 0.001 | 0.030 | 0.963 | – 0.019 | 0.036 | 0.600 |
| C dummy payroll tax | – 0.044 | 0.022 | 0.040 | – 0.044 | 0.024 | 0.066 |
| C dummy consumer price | 0.000 | 0.028 | 0.988 | – 0.021 | 0.030 | 0.479 |
| C dummy producer price | 0.026 | 0.024 | 0.278 | 0.042 | 0.027 | 0.127 |
| $\overline{R}^2$ | 0.021 | | | 0.081 | | 0.081 |
| S.E. of regression | 0.094 | | | 0.089 | | 0.089 |
| Median value dependent variable | – 0.064 | | | – 0.064 | | 1.564 |
| Mean dependent variable | – 0.089 | | | – 0.089 | | |
| SD dependent var | 0.093 | | | 0.093 | | |
| Objective | 6.087 | | | 1.564 | | |
| Observations | 223 | | | 223 | | |

It is remarkable that the fit is very poor. Of all possible non-FRC dummies only the time series and the Anglo Saxon dummy provide some explanatory power. OLS regressions are in line with the LAD estimates, but are somewhat more pronounced.

From table C.15 it follows that the inclusion of labour productivity and consumer price matters. In case of the consumer price, it makes a difference whether it has been used as deflator for wages (C dummy). Restrictions (e.g. through a price wedge variable) have hardly any impact on estimated elasticities.

As to our first question on the 'macro wage curve' the results provide some support. If we run an additional regression using just the Anglo Saxon, time series and the FRC dummies for the consumer price, the restrictions are not rejected by the data. The value of the objective function increases to 6.6, resulting in a test statistic of 29.5 (the critical value of $\chi^2$ (21) is 32.7). This implies that if all our data points had been obtained from simple regressions of the real wage on the unemployment ratio, the results would not systematically differ from what we observe now.

This conclusion is in line with the 'empirical law of economics' suggestion. From the tables it follows that the estimated relation has hardly any explanatory power. There are some differences across country groups, but the spread can hardly be explained. In the next chapter we will see that the 'best' value of the macro elasticity is very close to the results found in the wage curve literature.

Finally, our results do not support the hypothesis on the expected impact of the level of the replacement ratio on the unemployment elasticity of pay. Maybe the impact depends on the generosity of the welfare state. Regressions including the replacement ratio level for The Netherlands only did not yield the expected results either.

## System LS regressions

Tables C.16 to C.18 display the elasticities obtained from the LS systems regressions for producer and income taxes and prices. In all tables we see that short and long term elasticities generally differ, like in LAD regressions. The macro and average price elasticities are not the same, and again this is consistent with earlier results. Benchmark values, however, may substantially differ from those reported in Table 6.5-Table 6.7.

**Table C.16 Elasticities of pay, The Netherlands, system LS regressions**

| Observations: 53 | Long term elasticity | | Short term elasticity | | Sample mean | |
|---|---|---|---|---|---|---|
| | Macro | Average | Macro | Average | System | Full |
| Payroll tax(1+$s$) | – 0.870 | – 0.870 | – 0.568 | – 0.568 | – 0.616 | – 0.670 |
| Average income tax (1– $t_a$) | – 0.219 | – 0.219 | – 0.497 | – 0.497 | – 0.420 | – 0.391 |
| Consumer price ($p_c$) | 0.320 | 0.320 | 0.503 | 0.503 | 0.625 | 0.725 |
| Producer price ($p_y$) | 0.620 | 0.620 | 0.424 | 0.424 | 0.327 | 0.657 |

In case of the Netherlands, payroll tax elasticities are higher in absolute value compared to those in table 6.4. Income tax elasticities are smaller, although sample means do not differ that much. The reduction in price elasticities is more than 40%; this may partly be due to the sample mean of the output price elasticity. About 65% of the observations refer to sectoral output prices rather than 40% in the full sample; and the elasticity of pay of sectoral output prices is lower than the macro elasticity (see also Tables 6.5 to 6.7).

For Anglo Saxon countries the elasticities of the average income tax retention ratio are virtually the same as in Table 6.6. Long term payroll tax elasticities are smaller, but the short run values are higher. Like for the Netherlands, consumer and producer price elasticities are much smaller. In the long run, values of the producer price elasticity are higher than in short run, but the difference is larger than in case of LAD estimates. For the consumer price elasticity the short run elasticity is highest; this contradicts the results of Table 6.6.

**Table C.17 Elasticities of pay, Anglo Saxon countries, system LS regressions**

| Observations: 53 | Long term elasticity | | Short term elasticity | | Sample mean | |
|---|---|---|---|---|---|---|
| | Macro | Average | Macro | Average | System | Full |
| Payroll tax(1+$s$) | – 0.681 | – 0.681 | – 0.379 | – 0.379 | – 0.616 | – 0.670 |
| Average income tax (1– $t_a$) | – 0.309 | – 0.309 | – 0.587 | – 0.587 | – 0.420 | – 0.391 |
| Consumer price ($p_c$) | 0.485 | 0.485 | 0.668 | 0.668 | 0.625 | 0.725 |
| Producer price ($p_y$) | 0.477 | 0.477 | 0.281 | 0.281 | 0.327 | 0.657 |

**Table C.18 Elasticities of pay, Other countries, system LS regressions**

| Observations: 53 | Long term elasticity | | Short term elasticity | | Sample mean | |
|---|---|---|---|---|---|---|
| | Macro | Average | Macro | Average | system | full |
| Payroll tax(1+$s$) | – 0.681 | – 0.681 | – 0.379 | – 0.379 | – 0.616 | – 0.670 |
| Average income tax (1– $t_a$) | – 0.309 | – 0.309 | – 0.587 | – 0.587 | – 0.420 | – 0.391 |
| Consumer price ($p_c$) | 0.485 | 0.485 | 0.668 | 0.668 | 0.625 | 0.725 |
| Producer price ($p_y$) | 0.477 | 0.477 | 0.281 | 0.281 | 0.327 | 0.657 |

Results for other countries are exactly the same as in case of Anglo Saxon countries. The only difference between both country groups in tables 6.6 and 6.7 concerns the unemployment elasticity of pay. We will discuss this elasticity now. Table 6.11 summarizes the results of regressions on the elasticities of $p_c$, $p_y$ using a common sample of 48 observations.

**Table C.19 Elasticities of pay, LS regressions ($p_c$, $p_y$, $u_r$)**

| Observations: 48 | Long term elasticity | | Short term elasticity | | Sample mean | |
|---|---|---|---|---|---|---|
| | Macro | Average | Macro | Average | System | Full |
| The Netherlands | | | | | | |
| Consumer price ($p_c$) | 0.618 | 0.684 | 0.618 | 0.684 | 0.662 | 0.725 |
| Producer price ($p_y$) | 0.186 | 0.027 | 0.186 | 0.027 | 0.336 | 0.657 |
| Unemployment rate ($u$) | – 0.062 | – 0.056 | – 0.062 | – 0.056 | – 0.106 | – 0.094 |
| | | | | | | |
| Anglo Saxon countries | | | | | | |
| Consumer price ($p_c$) | 0.274 | 0.340 | 0.274 | 0.340 | 0.662 | 0.725 |
| Producer price ($p_y$) | 0.654 | 0.496 | 0.654 | 0.496 | 0.336 | 0.657 |
| Unemployment rate ($u$) | – 0.004 | 0.003 | – 0.004 | 0.003 | – 0.106 | – 0.094 |
| | | | | | | |
| Other countries | | | | | | |
| Consumer price ($p_c$) | 0.638 | 0.705 | 0.638 | 0.705 | 0.662 | 0.725 |
| Producer price ($p_y$) | 0.306 | 0.147 | 0.306 | 0.147 | 0.336 | 0.657 |
| Unemployment rate ($u$) | – 0.071 | – 0.064 | – 0.071 | – 0.064 | – 0.106 | – 0.094 |

Again, the sample mean of the producer price elasticity is much smaller than in the full sample. Values for price elasticities are not only different from those in the LAD regressions, but also from LS regressions in tables C.16 to C.18. In addition, the size of the estimated coefficient of the sector dummy for the Netherlands in the equation of $p_y$ is unrealistic: it implies a negative sectoral price elasticity of pay. In case of the Anglo Saxon countries, the country dummies for $p_c$ and $p_y$ are substantial (about 0.4) and opposite in sign. As a result, producer price elasticities are much higher than those of other countries while for the consumer price elasticities the opposite holds. Unemployment elasticities of pay are almost the same for other countries, compared to the LAD results in table 6.7. In case of the Netherlands elasticities of $u_r$ are somewhat smaller while values for Anglo Saxon countries are almost zero.

What is the conclusion? Clearly considerable differences in sample size and composition hamper a meaningful comparison between LAD and LS system regressions. Also, the relative sensitivity to outliers of LS as compared to LAD results in relatively high values of the coefficients of specific dummies. Nevertheless, tax elasticities are rather similar and corresponding distinction between short and long term values is confirmed. Price elasticities are not easily compared and their values are sometimes unrealistic. Unemployment elasticities of pay obtained from both methods reasonably match. In case of Anglo Saxon countries, the size of the country dummy reduces the elasticity towards zero.

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